Deloro Mine Site Cleanup
Mine Area Closure Plan
Final Report

Prepared for:

ONTARIO MINISTRY OF THE ENVIRONMENT

Prepared by:

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Executive Summary

The Deloro Mine/Refinery Site, located in Eastern Ontario, began operation as a gold mine in the 1860s. Over the next 100 years, site activities also included the smelting and refining of a number of other elements including arsenic, silver, and cobalt. Activities associated with the mining, smelting, and refining of metals ceased in the 1950s. These historical activities at the site have resulted in significant environmental impacts to the soil, groundwater, surface water, and sediment quality both onsite and offsite.

Abandonment of the site by its owner(s) forced the Ontario Ministry of the Environment (MOE) to take control of the property in 1979, and to initiate control measures to limit the environmental impact from the site. Remedial initiatives by the MOE have resulted in reductions of arsenic loadings to the Moira River. Arsenic loading to the Moira River has been reduced by more than 80 percent from an annual average of 52.1 kg/day in 1979 to an annual average of less than 10 kg/day since 1983.

To provide further treatment, and to mitigate any unacceptable impacts on human health and the environment, CH2M HILL Canada Limited (CH2M HILL, formerly CH2M Gore & Storrie Limited [CG&S]) was retained by the MOE to develop and implement a comprehensive rehabilitation program focusing on four individual areas of concern at the Deloro Mine Site. These areas included the Mine Area, the Industrial Area, the Tailings Area and the Young's Creek Area. Subsequently, a detailed evaluation of rehabilitation alternatives was conducted by CH2M HILL in 2002/2003 separately for each of these four areas, which resulted in a rehabilitation alternative being recommended for each area of the site. CH2M HILL then further developed the recommended rehabilitation alternative by completing a separate Closure Plan for each area of the site. This report serves as the Closure Plan for the Mine Area (Main Mine and Remote Mine Areas) of the site.

The mining at Deloro was originally centred on the Gatling and Tuttle Shaft Area of the site. This section was the location of a prominent quartz veining system along a regional structural feature. By today's standards the mine shafts in this area were all fairly limited in size, with small volumes of waste rock produced. Waste rock was dumped in the general vicinity of the mine shafts, and is readily identifiable. Ore processing occurred in the Gatling and Tuttle Shaft Area; however, none is thought to have been carried out at the Hawkeye, 5 Acres, Pearce, or Cook's Shaft areas. Limited quantities of waste rock are also associated with the former Hawkeye, 5 Acres, Pearce, and Cook's Shaft areas. All other onsite mine workings appear to have been exploratory trenches and adits with minimal waste rock production.

A Site-Specific Risk Assessment (SSRA)was carried out for the site to determine the potential for health risks to humans and wildlife. The modifications to the recommended rehabilitation alternatives specific to the Mine Area, which were identified through completing the draft SSRA, included:

- Excavation of areas of highly leachable wastes/soils in the Main Mine Area with increased coverage of marginally leachable soils
- Excavation of selected areas of highly leachable wastes in the Remote Mine Area west of the Tailings Area to the Moira River

The identified wastes in the Main Mine Area are waste rock, incidental waste deposits, highly leachable wastes/soils, and marginally leachable soils that are present on the ground surface and in the shallow subsurface. These wastes have unacceptable human health and/or ecological risks. Water quality impacts to the Moira River in this area include groundwater discharge from the Tuttle Shaft, and surface water runoff from the contaminated waste rock, soil, and concentrated mine wastes. In the Remote Mine Area, waste rock contains high arsenic levels as well as some areas of unacceptable human health and/or ecological risks, and potentially highly leachable wastes in some of the the surfical soils. However, the impacts to water quality associated with these remote waste rock areas are considered to be insignificant relative to those occurring at the Gatling and Tuttle Shaft Area. Shallow soils containing arsenic and other constituents above the SSRA criteria for potable groundwater conditions can create an unacceptable impact and require management.

The following Closure Plan is being recommended for the Mine Area:

- **Main Mine Area:** Increase pumping from Tuttle Shaft; cover waste rock with geofabric filter, clay, topsoil, and then vegetate; cover marginally leachable soils with clay, "clean" fill material, topsoil, and then vegetate; selective consolidation of soils with unacceptable SSRA risks and highly leachable wastes (>4,000 ppm As) in the Industrial Area below the engineered cover; infill with "clean" fill materials, cover with topsoil, and then vegetate.
- **Remote Mine Area:** Cover waste rock with geofabric filter, clay, topsoil, and then vegetate; excavate and consolidate soils with unacceptable SSRA risks and highly leachable wastes, if present (also to be consolidated in Industrial Area under the engineered cover); infill with "clean" fill materials; cover with topsoil; and then vegetate.

The recommended Closure Plan was based on increased pumping from the Tuttle Shaft, covering the waste rock areas, excavation and consolidation of highly contaminated materials, and capping of the less contaminated materials.

Site-wide regulatory approvals that must be applied for and issued will be sought from the following agencies:

- Ministry of the Environment (MOE) certificates of approval for sewage and waste disposal, permits to take water, and Part V approval under the provincial *Environmental Protection Act*.
- Conservation Authority regulations: the *Fill, Construction, and Alteration to Waterways Regulation*.
- The Ministry of Natural Resources (MNR) is responsible for issuing Work Permits under several different Provincial Acts including the *Forest Fire Prevention Act*, *Lakes and Rivers Improvement Act*, and *Public Lands Act*.
- The Department of Fisheries and Oceans (DFO) is responsible for the *Navigable Waters Protection Act* and the *Fisheries Act*. The Canadian Coast Guard (CCG) may also be involved.
- Environmental Assessment (EA) and Canadian Nuclear Safety Commission (CNSC) licencing will be required to manage the non-radioactive and radioactive wastes on the site.

The Closure Plans for the Deloro Mine Site were developed based on the Ministry of Northern Development and Mines (MNDM) *Mining Act* requirements. MNDM has agreed to review the Closure Plans relative to accepted standards for closure and rehabilitation of mines in Ontario, although a specific approval will not be issued.

This report contains information related to health hazard assessment (Section 4.6), and environmental and community health protection plans (ECHPP) (Section 4.7) to minimize the potential impact of the closure activities on workers, local residents, and the environment.

Operations, maintenance, and monitoring (OMM) for the Mine Area after the implementation of the Closure Plan include pressure testing the upgraded Tuttle Shaft groundwater collection system and routine pump maintenance at the Tuttle Shaft; periodic maintenance of the earth caps to repair any erosion damage and areas of vegetative stress; rodent control, watering, and damaged plant replacement; maintenance of the reconstructed riverbank (if applicable); perimeter fence maintenance; and monitoring the water quality of the Moira River upstream and downstream of the Mine Area. A detailed OMM plan should be established for the Mine Area following implementation of the recommended Closure Plan.

The monitoring program can be summarized as noted in the following table:

MONITORING PROGRAM

Type of Monitoring	Description	Duration	Frequency
Physical Stability	Visual inspection of surface of sealed mine workings, vegetative cover, erosion problems, tension cracks, seeps	Indefinitely following capping (Note: Inspection of surface of sealed mine workings for subsidence is ongoing, following closure of mine workings during 1992 to 1995)	Semi-annual for Years 0 to 3 Annual after Year 3
Water Quality	Sampling and analysis of surface water at key selected locations	During the excavation stage of the project	Daily during excavation
Water Quality	Sampling and analysis of surface water at key selected locations	Indefinitely following capping	Semi-annual for Years 0 to 5 Annual after Year 5
Leachate Quality	Sampling and analysis of leachate at Tuttle Shaft	Indefinitely following capping	Semi-annual for Years 0 to 5 Annual after Year 5
Pumping and Conveyance	Visual inspections and pressure testing	Throughout the pumping period	Monthly (with alarms in place)
Biomonitoring	Vegetation tissue sampling, soil moisture monitoring, visual observations	Indefinitely following capping	Annually for Years 0 to 5 Once every five years for the next 20 years Once every 10 years thereafter
ATP Influent/ Effluent Quality	Sampling and analysis of influent/effluent from the ATP	Refer to the Closure Plan for the Industrial Area	Refer to the Closure Plan for the Industrial Area

During the implementation and operation of the rehabilitative measures at the site, there is a potential that malfunctions (i.e. in design, construction, or commissioning) or accidents (i.e. due to acts of nature) could occur. These malfunctions and accidents can adversely affect remediation activities, and OMM of the site, resulting in delays or costly mitigation measures. These events must be considered, and mitigation measures must be developed to

ensure environmental impacts are minimal and acceptable. This report contains mitigation measures for potential malfunctions and accidents for the short-term during preparation activities, medium-term during remediation activities, and during the long-term OMM activities.

The Mine Area work was divided into work packages. Recommended sequencing of work packages is presented below:

IDENTIFICATION OF WORK PACKAGES

Package I.D.	Work Package Description
MMA-WP#1a	Excavation and removal of the waste materials at the former arsenic dump, a portion of the Moira River bank (if required), and within areas including sample locations GB3001, GB3002, GB3003, GB3004, GB3005, SS3022, SS3026, SS7030, SS7032, SS7033, SS7034, SA6, SA21, SA26 and 46, and the small volume (approximately 5 m^3) of low-level radioactive slag. Infilling of the excavations to grade with "clean" fill material, topsoil, and then vegetating, including reconstructing a portion of the Moira River bank (if required). If human health or ecological risk is present in underlying soil, those areas will require a minimum cover of 1,500 mm to top of topsoil (simple earth [clay] cap design).
RMA-WP#1b	Excavation and removal of soils within areas including SS7040, adjacent to Hawkeye Shaft; 72, adjacent to Pearce Shaft; and SS3002, SS3004, 56, and 57, adjacent to and west of the Tailings Area, followed by infilling of the excavations to grade with "clean" fill material, topsoil, and then vegetating.
MMA-WP#2a	Regrade and cover waste rock with geofabric filter; cover with clay, topsoil; then vegetate. Consolidate and cover the three suspected marginally leachable soil areas with clay, "clean" fill material, topsoil, and then vegetate. Clay to be compacted in place.
RMA-WP#2b	Regrade and cover waste rock with geofabric filter, cover with clay, "clean" fill material, topsoil, and then vegetate. Clay to be compacted in place.
MMA-WP#3	Tuttle Shaft pumping system installation: Pump, piping, overhead piping support structure, pipe insulation, and heat tracing.

Note: Contaminated materials excavated as part of MMA-WP#1a and RMA-WP#1b will be transferred for consolidation in the Industrial Area and covered with an engineered cap.

The anticipated construction impacts and mitigation measures are as follows:

ANTICIPATED CONSTRUCTION IMPACTS AND MITIGATION MEASURES

Construction Impacts	Mitigation Measures
Clearing and grubbing of trees and shrubs during site preparation	Altered areas should be revegetated with native/clonal species. If possible, minimize cutting trees larger than 100 mm diameter.
Suspended particulates in air from heavy equipment/vehicles adversely affecting air quality	Dust suppression methods will be utilized on an "as needed" basis.
Vegetation removal for temporary road construction or existing road upgrades to accommodate heavy vehicles	Roads not required for the future OMM of the site will be excavated, backfilled with appropriate material, and revegetated to blend in with existing cover/cap requirements.
Suspended sediment in surface water	Diversion dams/trenches and geotextile silt fencing will be used to isolate surface water flows from active excavation areas. Sediment settling/retention ponds may be required.

The implementation schedule of work packages is presented below:

IMPLEMENTATION SCHEDULE OF WORK PACKAGES

Package I.D.	Work Package Implementation Schedule
MMA-WP#1a	Excavation and removal of the waste materials and low-level radioactive slag; infilling of the excavations to grade with "clean" fill material and topsoil; then vegetating in Year 1, including reconstructing a portion of the Moira River bank (if required).
RMA-WP#1b	Excavation and removal of soils; infilling of the excavations to grade with "clean" fill material and topsoil; then vegetating in Year 1. (As before, a thicker 1.5-m cap may be needed.)
MMA-WP#2a	Regrading and covering of waste rock with geofabric filter; covering with clay (compacted), and topsoil; then vegetating in Years 1 and 2. Consolidating and covering the marginally leachable soil areas with clay (compacted), "clean" fill material, topsoil, and then vegetating in Years 1 and 2.
RMA-WP#2b	Regrading and covering waste rock with geofabric filter, clay (compacted), and topsoil, and then vegetating in Year 1.
MMA-WP#3	Installing pump and piping in year following the completion of the Industrial Area closure between the Tuttle Shaft and the equalization pond.

The estimated cost of each work package is presented as follows:

Package I.D.	Work Package Cost
MMA-WP#1a	$1,095,000
RMA-WP#1b	$360,000
MMA-WP#2a	$531,000
RMA-WP#2b	$134,000
MMA-WP#3	$73,000

The total costs associated with the recommended alternative include a capital cost of $2,193,000 and an annual weighted OMM cost of $66,430 or $1,091,000 for a planning horizon of 20 years. The net present value of the recommended alternative, assuming an effective interest rate of five percent and the planning horizon of 20 years, is $3,284,000. The 20-year period was selected based on the assumption that it is a reasonable period for budgetary planning purposes.

Post-closure conditions are expected to provide a setting in the Mine Area that is in significant contrast to the existing conditions. The soil cover and vegetation at locations such as the waste rock areas that have little cover vegetation will provide a cover that will blend into the current surrounding forested area.

The Closure Plans will be the subject of additional public consultation and stakeholder review in addition to providing supporting documentation for regulatory reviews and applications. **It is anticipated that the Closure Plans may need to be revised, as a result of the public consultation and stakeholder review, and to incorporate the findings of ongoing studies such as the Site-Specific Risk Assessment and groundwater modelling studies. Revisions are expected to refine the recommended alternative for each main area of the site but not result in a fundamental change in direction.** The comments and

additional findings will be incorporated into the final rehabilitation strategy and implemented in the construction phase of the project.

CH2M HILL Canada Limited

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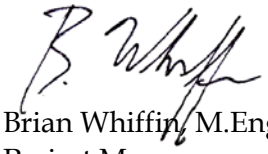

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List of Acronyms

AAQC	Ambient Air Quality Criteria
ATP	Arsenic Treatment Plant
C of A	Certificate of Approval
CCG	Canadian Coast Guard
CEAA	Canadian Environmental Assessment Act
CNSC	Canadian Nuclear Safety Commission
COC	Chemical of Concern
DFO	Department of Fisheries and Oceans
EA	Environmental Assessment
EAA	Environmental Assessment Act
ECHPP	Environmental and Community Health Protection Plan
EIS	Environmental Impact Study
EPA	Environmental Protection Act
FA	Federal Authority
GHASP	General Health and Safety Plan
GST	Goods and Services Tax
GUCSO	Guideline for Use at Contaminated Sites in Ontario
HADD	Harmful Alteration, Disruption, or Destruction
HHRA	Human Health Risk Assessment
HQ	Hazard Quotient
LLRW	Low-Level Radioactive Waste
masl	Metres Above Sea Level
MNDM	Ministry of Northern Development and Mines
MNR	Ministry of Natural Resources
MOE	Ministry of the Environment
MOEE	Ministry of Environment and Energy
MRCA	Moira River Conservation Authority
NPV	Net Present Value
NSCA	Nuclear Safety and Control Act
NWPA	Navigable Waters Protection Act
OCWA	Ontario Clean Water Agency
OMM	Operation, Maintenance, and Monitoring
OWRA	Ontario Water Resources Act
PC of A	Provisional Certificate of Approval
PPE	Personal Protective Equipment
PSW	Provincially Significant Wetland
PTTW	Permit to Take Water
PWQO	Provincial Water Quality Objectives
QC	Quinte Conservation
RA	Responsible Authority
RSC	Record of Site Condition
SDB	Standards Development Branch
SLERA	Screening Level Ecological Risk Assessment

SSRA	Site-Specific Risk Assessment
TDR	Time Domain Reflectometry
TERP	Transportation and Emergency Response Plan
TOR	Typical Ontario Resident
TSP	Total Suspended Particulate
VEC	Valued Ecosystem Component
VSC	Valued Social Component
WNSL	Waste Nuclear Substance Licence

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1. Introduction

1.1 Background

This section describes a brief history of the Deloro Mine Site and the associated environmental issues that arose from more than a century of mining related activities, the need to rehabilitate the site, and the purpose and organization of this document.

1.1.1 Deloro Mine Site

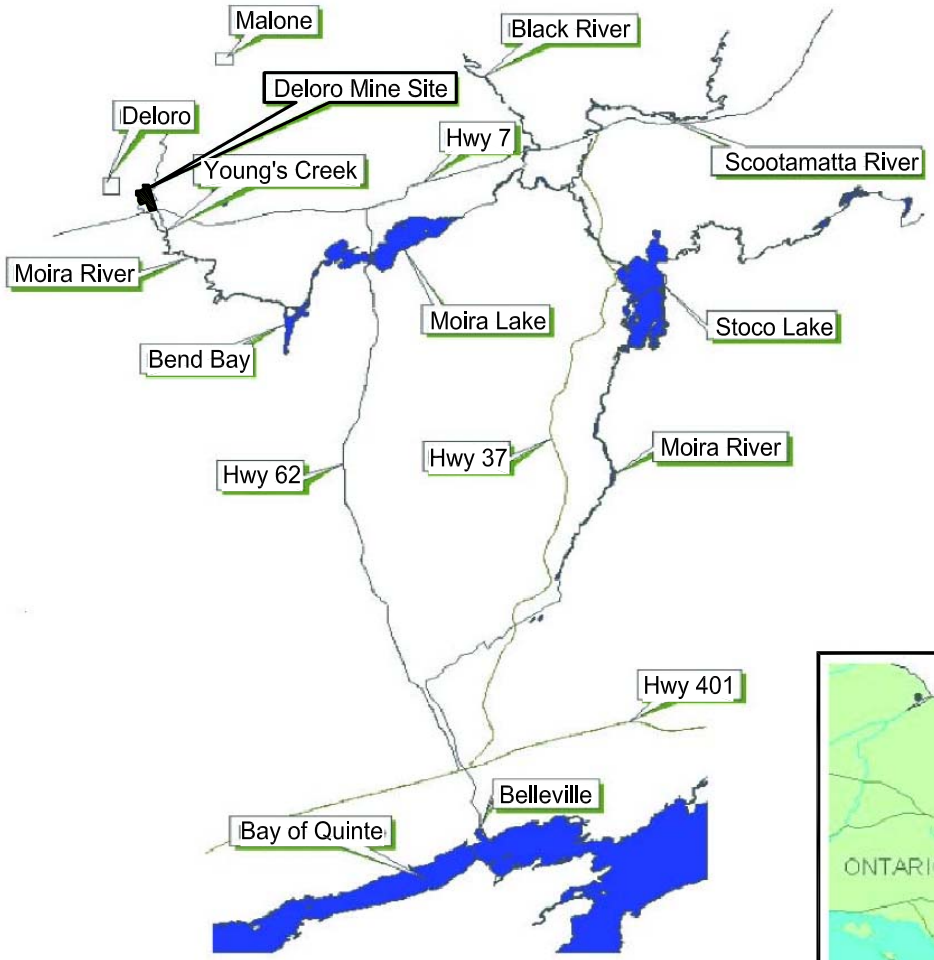
The Deloro site is located in Eastern Ontario (Figure 1-1) along the banks of the Moira River east of the Village of Deloro (Figure 1-2). The former refinery/smelter site (Industrial Area) is approximately 25 ha in area, and is located adjacent to the west bank of the Moira River. The Tailings Area is located east of the Industrial Area between the east side of the Moira River and the west side of Young's Creek. The entire property (Figure 1-3), which includes the Industrial Area, Tailings Area, Mine Area, and the onsite portion of Young's Creek, is approximately 202 ha in area (CH2M HILL, February 2002).

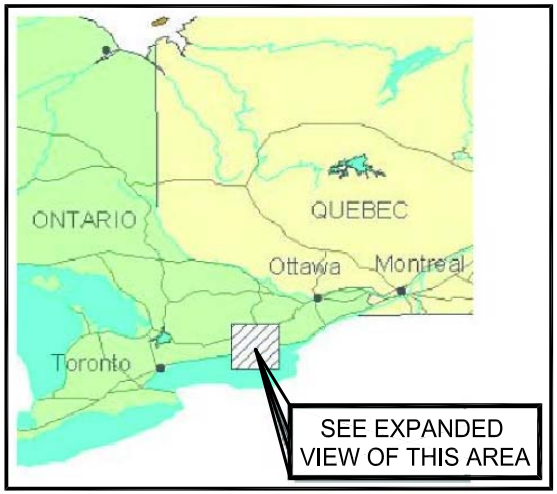
Access to the mine site is via Deloro Road, which is accessed from Highway 7, approximately 4 km east of Marmora. The principal population centres in the area are the Village of Deloro (pop. 180), and the Villages of Marmora (pop. 1,700) and Madoc (pop. 1,400), located approximately 5 km southwest and 10 km east of the mine site, respectively.

The Deloro site began operation as a gold mine in the 1860s and evolved over the next century to mine and refine gold, as well as smelting and refining of a number of other elements including arsenic, silver, and cobalt. It was the first plant in the world to produce cobalt commercially and was also a leading producer of stellite, a cobalt-chromium-tungsten alloy. Concentrates from uranium extraction were imported to the site and further processed to extract cobalt. Arsenic-based pesticides were produced from the by-products of smelting operations and continued as a main activity at the site until the market collapsed in the late 1950s.

A century of handling hazardous materials and chemicals has resulted in significant environmental degradation of the Deloro Mine Site. Large quantities of refining slag, mine tailings, calcium arsenate, and arsenical pesticides remained at the site. Fuels, chemicals, and raw materials, such as sulphuric acid, coke, lime, soda ash, caustic soda, liquid chlorine, salt, scrap iron, sodium chlorate, and fuel oil were handled at the site. Radioactive slag and tailings were produced as a result of the re-refining of by-products from uranium refining.

The Ontario government stepped in to take control of the site in 1979 due to failure of the owner to control environmental releases. The Ministry of the Environment (MOE) has been in care and control of the site since that time. Several rehabilitation actions have been implemented at the site that have significantly reduced releases from the site. In 1979, the annual average loading of arsenic to the Moira River was 52.1 kg/day. Since the Arsenic Treatment Plant (ATP) located in the Industrial Area of the site was put into operation in 1983, the arsenic loading to the river has been reduced by more than 80 percent, to an annual average of less than 10 kg/day. However, further work is required to reduce releases to acceptable levels and to secure the site for the long term. CH2M HILL Canada Limited (CH2M HILL) was retained to provide consulting engineering and project management services for the Deloro Mine Site Cleanup.





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DELORO MINE SITE CLEANUP

FIGURE 1-1
SITE LOCATION PLAN

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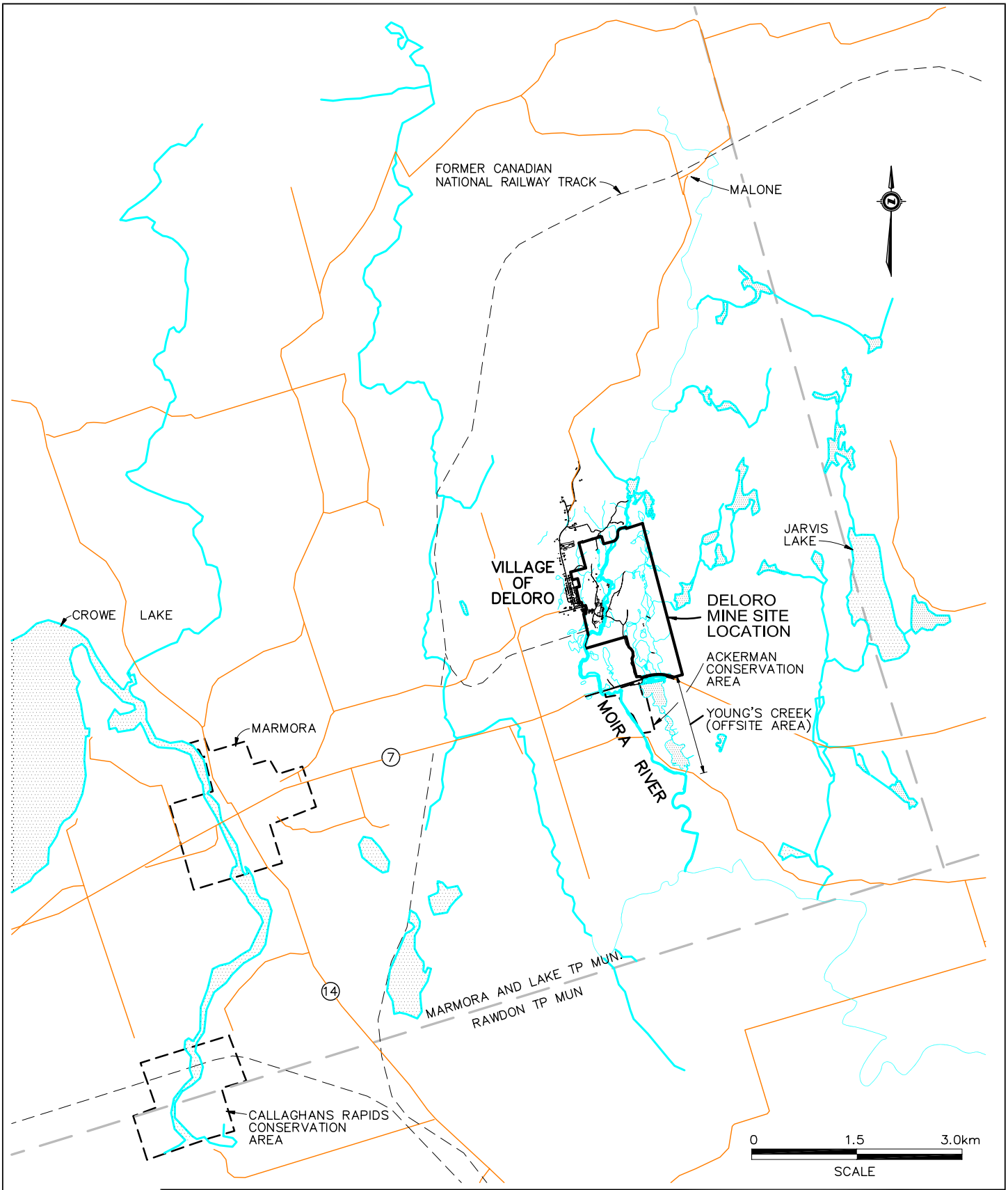

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DELORO MINE SITE CLEANUP

FIGURE 1-2
DELORO MINE SITE LOCATION

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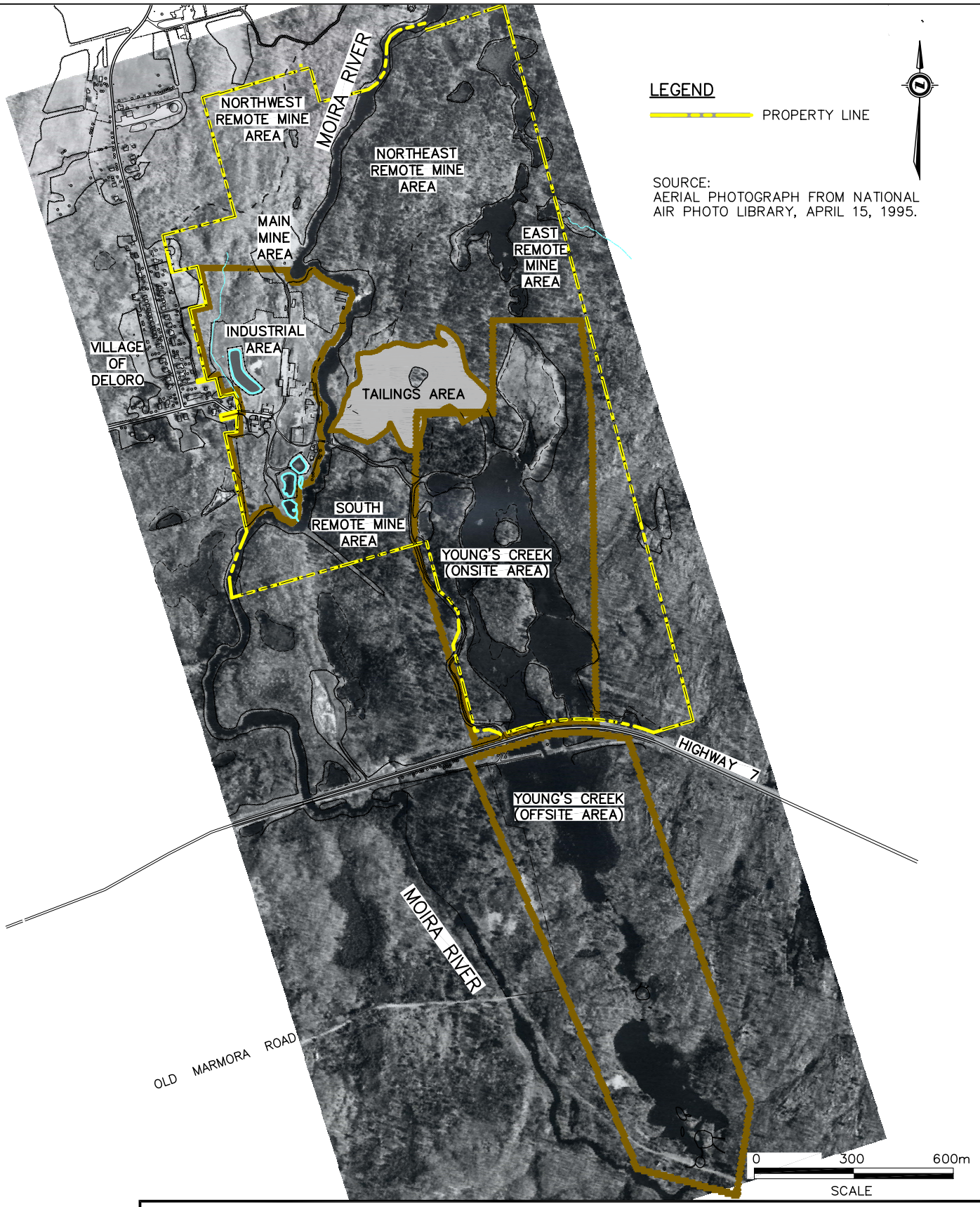

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DELORO MINE SITE CLEANUP

FIGURE 1-3: DELORO MINE/REFINERY SITE SHOWING THE INDUSTRIAL, MINE, TAILINGS AND YOUNG'S CREEK AREAS - DELORO, ONTARIO

PROJECT No. 119548

1.1.2 Rehabilitation Alternatives

CH2M HILL was retained by the MOE to develop and implement a comprehensive rehabilitation program for the closure of this former mine site. As part of this comprehensive rehabilitation program, CH2M HILL evaluated a broad range of rehabilitation alternatives and identified a recommended alternative for further development for each of the four areas within the mine site's footprint, as shown in Figure 1-3. Figure 1-3 shows the Main Mine Area as well as the Remote Mine Area which is comprised of the Northwest, Northeast, South, and East Remote Mine Areas. The limits of these four areas have been developed based on historical land use and waste disposal practices. The four areas are:

- The Industrial Area, where smelting and refining of the various ores were carried out
- The Tailings Area, where the by-products of the production phase were stored
- The Mine Area, on both the east and west sides of the Moira River
- The Young's Creek Area, which has been impacted from historical releases from the Tailings Area

The rehabilitation alternatives reports prepared by CH2M HILL are as follows:

- *Deloro Mine Site Cleanup – Industrial Area Rehabilitation Alternatives* (December 2003)
- *Deloro Mine Site Cleanup – Tailings Area Rehabilitation Alternatives* (October 2003)
- *Deloro Mine Site Cleanup – Mine Area Rehabilitation Alternatives* (October 2003a)
- *Deloro Mine Site Cleanup – Young's Creek Area Rehabilitation Alternatives* (May 2003)

1.1.3 Purpose of this Closure Plan

The overall objective of the Deloro Mine Site Cleanup is to successfully rehabilitate the mine site to mitigate, within reason, any unacceptable impacts on human health or the environment. As part of this overall objective, several area-specific objectives have been developed. Achieving these objectives, in conjunction with the other area-specific objectives, will aid in the successful rehabilitation of the Deloro Mine Site.

The Closure Plans for each of the four areas of the site are based on the site-wide closure objectives identified in the report entitled *Deloro Mine Rehabilitation Project – Development of Closure Criteria, Final Report* (CG&S, October 1998), including area-specific closure objectives (see Section 1.3), and the recommended rehabilitation alternatives developed for each area. The recommended alternatives are further developed in the four Closure Plans as follows:

- *Deloro Mine Site Cleanup – Industrial Area Draft Closure Plan*
- *Deloro Mine Site Cleanup – Tailings Area Draft Closure Plan*
- *Deloro Mine Site Cleanup – Mine Area Draft Closure Plan*
- *Deloro Mine Site Cleanup – Young's Creek Area Draft Closure Plan*

Even though the Crown (i.e. the Provincial Government) is exempt from the requirements of the *Mining Act,* the Closure Plans have been developed to satisfy the requirements of the document entitled *Rehabilitation of Mines, Guidelines for Proponents* (MNDM, 1995). The latter document includes provisions for protection of the environment.

The Closure Plans will be the subject of additional public consultation and stakeholder review in addition to providing supporting documentation for regulatory reviews and

applications. **It is anticipated that the Closure Plans may need to be revised, as a result of the public consultation and stakeholder review, and to incorporate the findings of ongoing studies such as the Site-Specific Risk Assessment and groundwater modelling studies (see Section 2). Revisions are expected to refine the recommended alternative for each main area of the site but not result in a fundamental change in direction.** The comments and additional findings will be incorporated into the final rehabilitation strategy and implemented in the construction phase of the project.

An integrated technical cleanup plan will be prepared to present a summary of the four Closure Plans, and to optimize and prioritize the remedial actions.

1.1.4 Organization of Report

This report consists of ten sections, including the introduction. Section 2 summarizes the findings of other technical studies undertaken to support the Closure Plans. A detailed description of the recommended alternative is presented in Section 3 including site security and safety, building demolition, waste removal and handling, waste isolation and containment, mine workings, crown pillars and surface workings, water management, final site grading, and site rehabilitation and re-vegetation. Section 4 presents an implementation plan for the selected alternative including identification, sequencing, scheduling, and a cost estimate of work packages, anticipated construction impacts and mitigation measures, an environmental and community health protection plan (ECHAPP), and other operational procedures. Section 5 details operations and maintenance efforts outlined under the recommended remedial alternative. A recommended monitoring program is discussed in Section 6, focusing on physical monitoring, chemical stability, and water quality, biomonitoring, and site management. Potential malfunctions and accidents, and corresponding mitigation measures are examined in Section 7. Section 8 details the expected post-closure conditions and uses of the site. Known and anticipated approval requirements are outlined in Section 9, and Section 10 lists the references used in the preparation of this report. The detailed cost opinion is provided in Appendix A.

1.2 Related Reports and Studies

A list of reports and other documents referenced in this document is provided in Section 10. Related reports and studies are on public record and available for review from the Kingston MOE office.

The Ontario Ministry of Northern Development and Mines (MNDM) recommends in *Rehabilitation of Mines, Guidelines for Proponents* (MNDM, 1995) that the Closure Plan include sections on "Current Environmental Conditions", a "Project Description", and a range of "Rehabilitation Alternatives". These three sections were provided in detail for the Mine Area in the document entitled *Deloro Mine Site Cleanup – Mine Area Rehabilitation Alternatives, Final Report* (CH2M HILL, October 2003a) and are therefore not repeated in this report. The exception is the rehabilitation alternatives, which are listed in Section 1.4 below.

1.3 Cleanup Approach and Criteria

Extensive previous investigation and evaluation has been undertaken at the Deloro Mine Site. Based on strategic decisions made by the MOE in the early 1990s, the most viable

solutions for management of residuals at the Deloro Mine Site involve onsite management through isolation and containment techniques. An approach that includes cleanup to "natural background" is prohibitively costly and is not considered to be the most prudent expenditure of public funds. Instead, a more pragmatic approach has been adopted in which mitigative action is directed at risk reduction. In this approach, risks to both human health and the environment are considered under both the current and reasonably expected future land uses. This approach has been recognized as an option in the MOE's *Guideline for Use at Contaminated Sites in Ontario* (GUCSO) (MOE, 1997), in which it is referred to as the Site-Specific Risk Assessment (SSRA). The SSRA is the approach selected by the MOE as proponent for the Deloro site rehabilitation.

The strategic direction for site cleanup, involving the onsite management of wastes through isolation and containment methods as primary remediation techniques, is described in the report entitled *Deloro Mine Rehabilitation Project - Development of Closure Criteria, Final Report* (CG&S, October 1998). This translates into the following project objective:

> *To successfully rehabilitate the Deloro Mine Site to mitigate any unacceptable impacts on human health or the environment in compliance with relevant environmental policies and regulations.*

To satisfy this objective, specific site-wide and distinct area closure objectives were developed. The site-wide closure objectives are as follows:

1. Reducing the loading of arsenic and other contaminants to the Moira River
2. Compliance with appropriate regulations and policy
3. Satisfying the general intent of the *Mining Act* and related draft regulations
4. Reducing/controlling impact/risk to acceptable levels
5. Demolition of unneeded buildings to ground level
6. Prioritizing remedial action implementation according to risk reduction
7. Minimizing perpetual operations and maintenance
8. Restoration of the site to reflect its natural surroundings
9. Securing the site for the indefinite future
10. Managing the wastes over the smallest possible area

The overall closure objective is intended to achieve a 90 percent reduction in arsenic discharge to the Moira River to achieve Provincial Water Quality Objectives (PWQOs) at the intersection of the Moira River and Highway 7 (CG&S, October 1998). Monitoring will be performed to assess actual performance. Contingency measures have been incorporated as part of the recommended alternative for each area of the site and are further developed as part of the Closure Plans. These site-wide closure objectives were further refined into area-specific closure objectives for each area of the site.

Closure objectives specific to the Mine Area include:

1. Develop a rehabilitation Closure Plan supported by an SSRA
2. Develop/implement risk reduction plans according to site-wide priorities
3. Consolidate contaminated (heavily impacted) materials into limited areas of the site (where appropriate)
4. Restore closed mine areas to blend in with native conditions (current natural surroundings)

1.4 Alternatives Considered

As previously noted, the Deloro Mine Site cleanup is being conducted according to the GUCSO (MOE, 1997) following the SSRA option. The approach has been adapted or enhanced to meet other regulatory or best management practices including the *Canadian Environmental Assessment Act* (CEAA).

A process was developed to generate potential remedial alternatives and select a recommended alternative for all areas of the Deloro site. This process is described in the document entitled *Mine Area Rehabilitation Alternatives, Final Report* (CH2M HILL, October 2003a). Initially, conceptual remediation methods that could have addressed some or all of the issues for each respective area of the site were identified. For instance, a method may address groundwater issues but not impacted sediment. These methods were evaluated with a screening process to identify which had the greatest potential to address the issues at the site, either alone or in combination with other methods. Improbable methods that did not have significant potential to contribute to a viable solution were eliminated early in the process. This resulted in a list of primary remediation methods that were retained for further evaluation.

The primary remediation methods were combined with enhancing features, based on the judgement and experience of the project team, to create a number of comprehensive remediation alternatives that addressed all of the environmental issues at the site. These comprehensive remediation alternatives were subsequently evaluated in a two-step process. The screening level evaluation served to eliminate comprehensive remediation alternatives (as opposed to conceptual remediation methods that had been previously screened) that were unlikely to meet all of the remediation needs for the area. This second level of screening led to a short list of comprehensive remediation alternatives that were the subject of a more detailed evaluation. The detailed evaluation led to the identification of a recommended remediation alternative, which would be developed further and subsequently implemented to address the environmental issues at the site.

The generation of the remediation alternatives consisted of combining the primary remediation method with enhancing environmental protection features, where appropriate, to produce three comprehensive remediation alternatives for the Main Mine Area and one for the Remote Mine Area.

The combination of the primary remediation method and the enhancing environmental protection features could generate numerous alternatives. In order to limit the number of alternatives to the most viable, the following was assumed:

- Increased pumping from the Tuttle Shaft was common to all Main Mine Area alternatives
- Excavation and removal of the concentrated wastes was common to all Main Mine Area alternatives
- The existing institutional controls (signs and fencing) for the entire mine site are considered to be sufficient in the interim, and the need for enhancements will be determined as part of the follow-up risk assessment

For the Main Mine Area, the following comprehensive remediation alternatives were generated:

- Increase pumping from Tuttle Shaft; cover entire affected soil/concentrated waste area with armour rock (enhancement), geofabric, clay, topsoil, and then vegetate (this includes covering waste rock in the same manner minus the armour rock)
- Increase pumping from Tuttle Shaft; cover waste rock with geofabric, clay, topsoil, and then vegetate; cover only heavily impacted soil/concentrated waste areas with armour rock (enhancement), geofabric, clay, topsoil, and then vegetate (Note: This was the recommended alternative identified in the Alternatives report)
- Increase pumping from Tuttle Shaft; cover waste rock with geofabric, clay, topsoil, and then vegetate; excavate and dispose of heavily impacted soil; cover excavated area with clay, topsoil, and then vegetate

For the Remote Mine Area, the following comprehensive remediation alternative was generated:

- Cover waste rock with geofabric, clay, topsoil, and then vegetate

1.5 Overview of the Recommended Alternative

The recommended alternative was based on some limited excavation of highly leachable wastes in the former "arsenic dump" area north of the Gatling Shaft, reducing infiltration through the surface of selected contaminant-affected areas of the Main Mine Area, and treatment of groundwater pumped from the Tuttle Shaft.

The recommended alternative has been refined in this Closure Plan based on recommendations in the draft SSRA (Section 2.1). Soil associated with sampling locations that showed unacceptable SSRA risks, high contaminant concentrations, and expected high leachability will be excavated and consolidated in the Industrial Area under an engineered cover. The limit of cover of the affected areas within the Main Mine Area has increased to reduce further the level of risk associated with human and wildlife exposure to the contaminants that are of concern. Also, based on the draft SSRA, three affected areas adjacent to the western and southern edge of the Tailings Area (within the Northeast and South Remote Mine Areas), along with an area west of the Hawkeye Shaft and one adjacent to the Main Mine Area, will require excavation and transport to the Industrial Area to further reduce the level of risk associated with human and wildlife exposure to the contaminants of concern.

Details of the refinements to the recommended alternative identified in Section 1.4 above are provided in Section 1.6.

1.6 Key Components and Recommended Alternative

The modified recommended alternative for the Mine Area, consistent with site closure objectives, contains the following key components:

- Increase pumping from Tuttle Shaft (year round)

- Cover waste rock with geofabric filter, clay, topsoil, and then vegetate (Main and Remote Mine Areas)
- Excavate selected areas containing low-level radioactive slag, highly leachable wastes/soils, and/or unacceptable SSRA risks, fill excavations, then vegetate (Main and Remote Mine Areas)
- Consolidate and cover selected areas containing marginally leachable soils and/or unacceptable SSRA risks with a simple earth (clay) cap consisting of topsoil, "clean" fill material, and compacted clay, and then vegetate (Main Mine Area)
- Reconstruction of a portion of the Moira River bank, if required

The proposed closure approach is presented in Figure 1-4. A detailed description of the alternative components is presented below.

1.6.1 Site Preparation

Prior to commencing the remedial work, site preparation work will be completed including mobilization of equipment (excavators, trucks, site trailers, and other equipment), construction of temporary access roads, and establishment of temporary services.

Vegetation and trees of various sizes, and maturity cover certain portions of the affected areas. Work in some of these areas will require the clearing and grubbing of the local flora. Clearing and grubbing should be kept to a minimum to preserve the natural condition of the site.

1.6.2 Tuttle Shaft Pumping System Upgrade

The current pumping system operates during low flow periods (dry periods) in the summer months and pumps the contaminated groundwater to the equalization pond. The pipeline is above ground and cannot be used in freezing temperatures in its current condition. Upgrades are required to increase the pumping of the deep groundwater at the Tuttle Shaft. Details are presented in Section 3.5.3.

1.6.3 Cover Waste Rock (Main and Remote Mine Areas)

Accumulations of waste rock from historical mine activities have been identified in both the Main and Remote Mine Areas. Waste rock was also used in the construction and stabilization of the east tailings dam wall, and will also require covering. This is addressed in the draft Closure Plan for the Tailings Area (CH2M HILL, March 2004). The recommended alternative includes isolating the waste rock from the surrounding environment to mitigate its leaching potential and to reduce the likelihood of human contact. The first step will be to regrade the waste rock with heavy machinery so that stormwater and melt runoff will be directed away from the covered waste rock. The regraded piles will be covered with a geofabric filter to minimize differential settlement and to simplify the installation of cover materials. Clay will then be used to cover the geofabric filter to a depth of 0.5 m to act as a low-permeability barrier. The clay will be compacted to the necessary density to optimize the low-permeability characteristics of this material. Vegetation and trees will be planted in a 0.15-m topsoil layer, placed above the clay layer to blend with existing conditions adjacent to the affected area, and graded to promote stormwater runoff. The total depth of the cover material will be a minimum of 0.65 m.

EQUALIZATION POND
PROPOSED YEAR-ROUND TUTTLE SHAFT PUMPING PIPELINE
NEW WESTERLY CREEK
ARSENIC TREATMENT PLANT
GARAGE
WASTE CONSOLIDATION AREA
INDUSTRIAL AREA
SLAG
FERRIC ARSENATE SLUDGE LAGOON (INACTIVE)
FERRIC ARSENATE SLUDGE LAGOON (ACTIVE)
RED SHAFT
5-ACRES SHAFT
TUTTLE SHAFT
GATLING SHAFT
HAWKEYE SHAFT
NORTHWEST REMOTE MINE AREA
MAIN MINE AREA
SOUTH REMOTE MINE AREA
NORTHEAST REMOTE MINE AREA
TAILINGS AREA
PEARCE SHAFT
COOK'S SHAFT
MOIRA RIVER
THE NEED FOR RIVERBANK RECONSTRUCTION IN THIS AREA NEEDS TO BE VERIFIED

SS3022 GB3002 GB3001 GB3003 GB3005 GB3004
SS7040 SS7034 SS7030 SS3026 SS7032 SA26 TP3 SA21 SA6 SS7033 46
SS3004 56 SS3002 57 72

LEGEND

- SS7034 ⊗ SEDIMENT SAMPLING LOCATION
- 1 : 100 YEAR FLOOD BOUNDARY
- MAIN MINE AREA BOUNDARY
- FENCE/PROPERTY LINE
- INDUSTRIAL AREA BOUNDARY
- SELECTIVE CONSOLIDATION FROM BEDROCK OUTCROPS AFTER GOLDER ASSOCIATES (1988)
- SELECTIVE CONSOLIDATION AND SIMPLE EARTH (CLAY) CAP
- CONSOLIDATED WASTE (FROM INDUSTRIAL AREA, MAIN MINE AREA AND REMOTE MINE AREAS) AND ENGINEERED COVER
- RIVERBANK RECONSTRUCTION
- WASTE ROCK COVER
- EXCAVATE, FILL, OR SIMPLE EARTH (CLAY) CAP, IF NECESSARY *(ESTIMATED EXTENT SUBJECT TO ADDITIONAL SAMPLING AND/OR CONFIRMATORY SAMPLING)*
- LOW-LEVEL RADIOACTIVE SLAG (1-2uSv/h 1m ABOVE GROUND SURFACE) REMOVE AND CONSOLIDATE WITH SIMILAR MATERIALS IN INDUSTRIAL AREA

0 50 100m
SCALE

NOTES:
TOPOGRAPHY DERIVED FROM AERIAL PHOTOGRAPH BY NORTHWAY MAP TECHNOLOGY LIMITED. (MAY 6, 1992)

CH2MHILL

DELORO MINE SITE CLEANUP

FIGURE 1-4
MAIN MINE AND REMOTE MINE AREAS
PROPOSED CLOSURE APPROACH

PROJECT No. 119548

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1.6.4 Excavation of Arsenic Dump Materials and Highly Leachable Wastes/Soils

Selected areas in the Main Mine Area containing highly leachable wastes/soils, and areas identified in the draft SSRA as posing unacceptable risks, will be excavated. To mitigate the potential of leachate from these materials migrating and having offsite impacts, and to eliminate human health and ecological risks, the materials will be excavated and consolidated with other highly leachable wastes and stored onsite in the Industrial Area, as shown in Figure 1-4.

The excavations will be backfilled to grade with appropriate readily available "clean" fill material and compacted to the necessary densities to mitigate differential settlement potential. The fill will be covered with a 0.15-m topsoil layer and vegetated if the soils below and adjacent to the excavation are deemed acceptable for this type of cover. Otherwise, if the remaining soils are found to be marginally leachable, or elevated human health or ecological risks are still present, a simple earth (clay) cap (described in Section 1.6.5) would be used to cover the excavated and adjacent areas.

In addition, selected soils in the Remote Mine Area (see Figure 1-4) will also be excavated and consolidated in the Industrial Area. These soils generally are not highly leachable but pose unacceptable human health or ecological risks. It is anticipated that these areas can be readily excavated and backfilled with "clean" fill material, eliminating the need for simple earth (clay) caps outside of the Main Mine Area that would otherwise require ongoing inspection and maintenance.

1.6.5 Simple Earth (clay) Cap

The recommended choice of cover for three suspected areas of marginally leachable soils in the Main Mine Area (see Figure 1-4) consists of layers of topsoil, fill, and compacted clay materials. The marginally leachable soils in these three areas will be consolidated to reduce the footprint of the simple earth (clay) cap. The topsoil provides the initial rooting medium for the cover vegetation, as well as some water storage capacity that will increase the effectiveness of the evapotranspiration properties of the vegetation. The fill material provides rooting medium of sufficient depth that root penetration and burrowing animals will not easily become exposed to the underlying marginally leachable soils. The compacted clay layer functions as a low-permeability layer to minimize percolation of water into the underlying materials. Further design effort, material availability, quality, and cost will determine the materials of construction and their sources.

In the alternatives report for the Mine Area, a cover thickness of 650 mm was selected to provide an infiltration barrier plus a suitable growing medium for plants. However, as a result of the draft SSRA (CH2M HILL, May 2003a), the capping thickness was increased to 1,350 mm for clay/fill materials, and 150 mm for topsoil, totalling 1,500 mm. This will reduce the potential for exposure of contaminants to burrowing animals and root penetration as part of the SLERA, as noted in Section 2.1.4. The use of armour rock as an enhancement has been abandoned, as the benefits are no longer valid with this depth of imported material. With exception, the waste rock areas will be covered with a geofabric filter, 500 mm clay, and 150 mm topsoil since the contaminants in these areas are not considered bio-available, and burrowing animals and tree roots are not expected to reach the underlying impacted materials.

1.6.6 Radioactive Slag

In the report *Deloro Mine Rehabilitation Project – Extent and Character of Radioactive Materials, Final Report* (CG&S, June 1999), low-level radioactive slag (1 – 2 µSv/h at 1 m above ground surface) was noted in an area adjacent to and west of the Tuttle Shaft. The volume of slag is estimated to be approximately 5 m^3. This material will be removed and consolidated with similar materials in the Industrial Area. The excavation will be filled with "clean" fill material, and then covered with a 0.15-m topsoil layer and vegetated.

1.6.7 Reconstruction of Moira River Bank

If required, a portion of the Moira River bank will be reconstructed.

From the current available data, it is not clear if waste rock, highly leachable wastes, or marginally leachable soils are within the 100-year flood elevation of the Moira River adjacent to the Main Mine Area. While this will need to be confirmed, an estimated 3,000 m^3 of material has been included in the volume required for consolidation in the Industrial Area.

2. Technical Studies and Supporting Documentation

2.1 Human Health and Ecological Risk Assessment

The MOE has developed guidance documents specific to the SSRA approach, which have been followed for this project. CH2M HILL has conducted SSRAs for both the human health and ecological risks for all areas of the site, based on the remediation alternatives recommended for each area of the site, and for various exposure scenarios and receptors. Results of these simulations have been used in the Closure Plans to modify and optimize the conceptual remediation designs first presented in the rehabilitation reports, as well as to satisfy the site-wide closure objectives. The SSRA also supports a Pathways Analysis, which is anticipated as part of the Canadian Nuclear Safety Commission (CNSC) licence application (see Section 2.2).

In support of the rehabilitation program, and as part of the development of the final cleanup plan, CH2M HILL completed a draft screening level ecological risk assessment (SLERA) and a draft human health risk assessment (HHRA) to assess the risks associated with the Deloro Mine Site and Young's Creek offsite area following rehabilitation. The risk assessment was completed for the entire site, including the four main areas and is documented in *Deloro Mine Site Cleanup – Deloro Mine Site Site-Specific Risk Assessment, Draft Report* (CH2M HILL, May 2003a). The risk assessment for the Young's Creek offsite area is documented in *Deloro Mine Site Cleanup – Offsite Young's Creek Site-Specific Risk Assessment, Draft Report* (CH2M HILL, May 2003b). This section presents a summary of the findings of the Deloro Mine Site SSRA and Young's Creek offsite area SSRA, respectively.

2.1.1 Summary of SSRA Results

The results of the SSRAs performed at the Deloro Mine Site and in Offsite Young's Creek are summarized below for the expected post-closure conditions. Additional information is provided in the executive summaries of the respective draft reports.

Human Health Risk Assessments (HHRA)

- All chemicals of concern (COCs), with the exception of arsenic, show results below the MOE recommended target of 1×10^{-6} for carcinogenic risk. It is the opinion of CH2M HILL that comparison to the typical Ontario resident (TOR) is more appropriate for qualification of carcinogenic arsenic risk. The carcinogenic risks for arsenic were determined to be less than the risk to a TOR for all scenarios, receptors, and routes of exposure.
- Risk at levels greater than the MOE recommended target hazard quotient (HQ) of one for non-carcinogenic risk was identified for the onsite Child Recreational User due to exposure to soil (onsite), sediment (onsite and offsite), and surface water (offsite). The elevated post-closure risk results may be mitigated with expansion of the areas to be excavated and/or covered as part of the recommended rehabilitation alternative, or the

results may be confirmed with additional sampling to confirm assumptions made in order to fill in the data gaps (see further discussion in Section 2.1.4 below).

- Young's Creek offsite post-closure Recreational User receptor risks were well below the comparison values previously identified. This may indicate that the rehabilitation effort originally proposed as part of the recommended rehabilitation alternatives reports can be reduced, assuming it also meets the requirements of acceptable risk to ecological receptors.
- Carcinogenic and non-carcinogenic risk due to ingestion of arsenic in onsite and offsite diet media (fish, ruffed grouse, berries) was greater than both the TOR and the HQ of one, respectively, for the Child and Adult Recreational Users. Confirmation of the presence and consumption of the diet media, as well as additional ecological data, is required to confirm these results.

Screening Level Ecological Risk Assessments (SLERA)

- Arsenic and cobalt are the COCs that are the main drivers of the elevated risk to onsite ecological receptors, as well as both pre- and post-closure Young's Creek offsite ecological receptors. Additional metals such as nickel, copper, chromium, and boron have also been identified as contributing to elevated risk to ecological receptors onsite and offsite.
- The results show that it is the concentration of the aforementioned COCs in soil that is of primary concern; however, elevated risk results have also been determined due to exposure to COCs in sediment and surface water.
- Almost all of the ecological receptors modelled show elevated risk due to one or more COCs for one or more routes of exposure.
- A significant degree of uncertainty is associated with the results at the screening level due to lack of site-specific information and assumptions made in order to fill in data gaps.

2.1.2 Key Points

The following items should be considered in determining a path forward for the SSRA:

- The draft risk results for some pathways and receptors (both ecological and human) were not calculated using site-specific data; instead, engineering assumptions and literature-derived information were used.
- The risks to ecological receptors are not conclusive given the information that is currently available.
- The results of the human health risk assessment indicate that further risk reduction efforts are required should the future land use allow recreational users on the onsite property.
- Risk to both ecological and human health receptors may be mitigated by extending cleanup to a larger area, or by addressing the aforementioned data gaps by undertaking a focused field program.

2.1.3 Primary Issues of Concern

Based on the information presented above, there are two issues of primary concern. These arise because previous sampling work has focused on delineation of impacted areas for cleanup with relatively little focus on the post-closure conditions. The two primary issues are: (i) the absence of analytical data for certain chemicals in specific media, and (ii) the lack of site-specific information required to evaluate the potential risk due to exposure to the chemicals present.

2.1.4 Revisions to Recommended Rehabilitation Alternatives

The modifications to the recommended rehabilitation alternatives, which were identified through completing the draft SSRAs, included:

- Expansion of coverage around the western perimeter of the Industrial Area
- Total coverage of the Main Mine Area – Excavation or capping of sampling locations containing elevated human health or ecological risks (see Figure 1-4). There may be a need to increase estimated extent of cleanup in the Main Mine Area, shown in Figure 1-4, depending on the results of additional future sampling.
- Excavation and/or capping of selected areas west of the Tailings Area to the Moira River (Remote Mine Area)
- Excavation of sediment from the Young's Creek Offsite area just south of Highway 7
- Excavation of sediment from the Young's Creek Offsite area just north of the confluence with the Moira River

In addition, in order to prevent exposure to burrowing animals as part of the SLERA (as well as due to the potential risk of transmigration of contaminants via tree roots), the thickness of any capped areas was increased to at least 1.5 m[1]. These recommended modifications to the recommended rehabilitation alternatives are addressed in the Closure Plan for each area of the site.

2.1.5 SSRA Recommendations

The SSRAs provided to the MOE documented the presence of metal contaminant-related issues within the Deloro mine onsite area and Young's Creek offsite area under the post-closure condition for the recommended rehabilitation alternative. While the SSRA results did not show unacceptable risk under most conditions, it also indicated that there were potential risks to plants and animals residing within these areas, as well as to humans spending time on the respective properties, in some circumstances. The extensive characterization work at the site has focused on the areas requiring remediation, with less effort directed to areas that will remain post-closure. As a result, the data used to define the nature and extent of post-closure contamination and subsequent risk, or to establish acceptable risk-based cleanup levels, is being augmented through further investigative work. Further, the conclusions for potential risks to ecological receptors/valued ecosystem components (VECs) were primarily based on published reference values consistent with a screening level risk assessment (e.g. GUCSO). These values are not specific to this site, the activities that have taken place, or the types of contaminants present. In order to confirm

[1] With exception, the cap thickness over slag and waste rock in the Industrial Area and Mine Area, respectively, was set at 0.65 m since these materials are not bioavailable.

that the recommended alternatives are appropriate and that remediation is not required over a broader area of the site, additional site information is being collected and risk evaluation is underway.

The results of the supplementary site information and risk assessment will be used to fill in the data gaps, increase the confidence in the risk evaluation, and update the draft results of the HHRA and SLERA for both the Deloro Mine Site SSRA report and Young's Creek Offsite SSRA report. The revised reports will be prepared in a format that is suitable for submission to the Standards Development Branch (SDB) of the MOE for their review following the additional work.

The following briefly lists the studies that are ongoing to verify and substantiate the conclusions of the SLERA and the HHRA:

- Additional chemical characterization of onsite soil, sediment, and surface water
- Collection of biota co-located with soil, sediment, and surface water samples for evaluation of site-specific bioaccumulation
- Biological and physical surveys within the Young's Creek onsite area
- Toxicity testing of the Young's Creek onsite area
- Bioavailability of COCs in soil, sediment, and surface water

2.2 Environmental Assessment

The MOE is seeking the necessary approvals to undertake a project involving the long-term onsite management of historic wastes, contaminated soil, and low-level radioactive wastes (LLRW) currently located at and in the vicinity of the Deloro Mine Site. The MOE understands that the licensing requirements for radioactive materials management under the *Nuclear Safety and Control Act* (NSCA) require that an Environmental Assessment (EA) under the CEAA be completed.

A report was prepared entitled *Deloro Mine Site Cleanup – Project Description, Final Report* (CH2M HILL, November 2002) to provide the appropriate federal authorities with a project description and related information to initiate the federal EA process under the CEAA. The project description provided relevant project site information and an overview of the anticipated construction, operation, remedial work, long-term monitoring, and consultation activities that will be undertaken as part of the cleanup of the Deloro Mine Site, including the offsite portion of Young's Creek.

The Canadian Nuclear Safety Commission (CNSC), in co-operation with the federal Department of Fisheries and Oceans Canada (DFO) subsequently prepared a document entitled *Environmental Assessment Guidelines (Scope of Project and Assessment), Environmental Assessment of the Deloro Mine Site Cleanup, Deloro, Ontario* (CNSC, October 2003). The purpose of the latter document is to provide guidance on the scope of a screening level EA to be conducted for the possession, management, and storage of nuclear substances at the Deloro Mine Site.

The CNSC notes in its EA Guidelines that a federal EA is required under the provisions of the CEAA. Under the CEAA, the scope of the project and the scope of the factors included in the assessment are determined by the Responsible Authority (RA) for the project. The RA

for this project is the CNSC. The DFO has indicated that it is an RA for this project if an authorization under the *Fisheries Act* is required; however, if it is not required, the DFO will withdraw as an RA but will remain as a Federal Authority (FA) for the project. The EA Guidelines describe the basis for the conduct of the EA, and focus the assessment on relevant issues and concerns. This document also provides specific direction to the proponent, the MOE, for the conduct and documentation of the technical EA study report, the responsibility for which will be delegated to them by the CNSC and DFO pursuant to subsection 17(1) of the CEAA. The EA Guidelines also provide a means of communicating the EA process to stakeholders.

CH2M HILL is currently preparing the EA study report on behalf of the MOE, and it will draw upon this and other Closure Plans.

2.3 Assessment of Likely Cumulative Effects

According to the CEAA, an EA must include an assessment of cumulative effects. CH2M HILL is addressing the assessment of cumulative effects in the EA study report. Cumulative effects will include an assessment of the potential effects of the Deloro Mine Site project in combination with the effects of other projects. In order to have a cumulative effect, the works and activities associated with other projects must overlap with both the geographical area and time frame of the Deloro Mine Site cleanup project. The cumulative effects assessment will be focused on the consideration of potential effects to valued ecosystem components (VECs) and valued social components (VSCs). If a cumulative effect is likely, then mitigation measures are applied and the potential effect is reassessed. If residual effects will be identified after the reassessment, then their significance will also be determined.

3. Description of the Recommended Alternative

3.1 Site Security and Safety

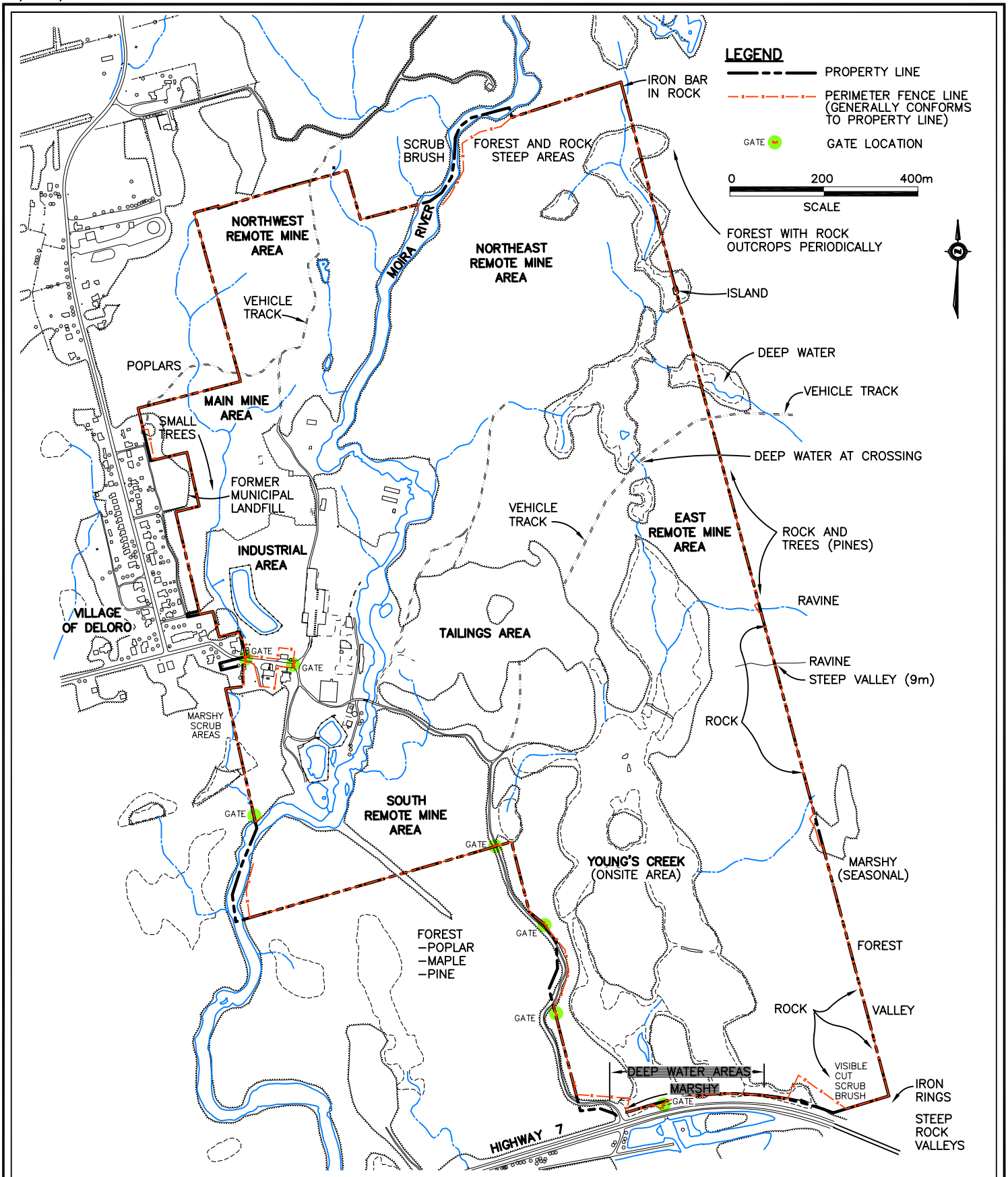
The Deloro Mine Site and the Ontario Clean Water Agency (OCWA) compound are completely enclosed by a 7,606 m perimeter fence that was completed in March 2000 (Figure 3-1). The majority of the chain link perimeter fence was installed to a height of 2.13 m, including 0.30 m of barbed wire. Adjacent to Highway 7, the perimeter fence was installed to a height of 2.13 to 2.44 m, without barbed wire to satisfy the Ministry of Transportation's Permit requirements.

There are seven points of entry to the site, mainly along the southern and western property boundaries, including five 9.0-m wide gates (one of which was installed in 2003), one 6.0-m wide gate, and one 1.2-m wide gate. The access gates will remain closed if not in use during the day, and all gates will be closed and locked at the end of each working day to prevent public access to the site during remediation activities.

Access to the Main Mine Area and the Northwest Remote Mine Area will be through the main site access gate near the ATP. The existing onsite access roads will be used for construction vehicles to access these areas. The Northeast, East, and South Remote Mine Areas are on the east side of the Moira River, and construction vehicle access will be from the access road off Highway 7 which travels along the Young's Creek Area.

Regarding use of the Deloro Mine Site bridge, an assessment and reconstruction of the onsite bridge crossing the Moira River was recently completed as reported in CH2M HILL's report, *Deloro Mine Rehabilitation Project – Assessment and Reconstruction of Deloro Mine Bridge, Final Report* (CH2M HILL, June 2002). The key conclusions and recommendations of the report are:

- The existing site bridge in 1998 was not suitable for the future construction activities.
- Although the site bridge was reconstructed in 2000, there will be loading limitations during site rehabilitation. The following equipment should not be permitted to cross the reconstructed site bridge:
  - A medium-tracked excavator
  - A loaded articulated truck
  - A loaded four-axle truck
- If future contractors plan to use other types of trucks with different axle spacing and loadings, then further analysis should be carried out by a design professional.
- The need for construction equipment to cross the Moira River during site rehabilitation should be assessed after completion of the various Closure Plans to prevent exceedances of the reconstructed bridge's loading capacity.



CH2MHILL

DELORO MINE SITE CLEANUP

FIGURE 3-1
PLAN OF PERIMETER FENCE

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Signs will be used to caution the public along Highway 7, in the Village of Deloro, and at site entrances. Signage may include "*Trucks Turning*" and other construction warning signs, as well as "*Danger – Access By Permit Only*" at access gates. Additionally, flagmen may be needed along Highway 7 to control traffic when heavy machinery, or large transport trucks enter or exit the highway.

3.2 Building Demolition

There are no buildings in the Main Mine and Remote Mine Areas. Therefore, building demolition does not apply.

3.3 Waste Removal and Handling

This section describes the main wastes, as well as identifies the location and estimated quantities of the wastes in the Mine Area. The removal, handling, transportation, and conditioning, if required, of these wastes during the implementation of the Mine Area rehabilitation alternative are also discussed.

Waste excavation from the Mine Area (Main and Remote Mine Areas) to the Industrial Area waste consolidation area will be in the order of approximately 32,405 m^3, as detailed below. Excavations will be infilled with "clean" material.

3.3.1 Main Waste Types

The identified wastes in the Main Mine Area are waste rock, incidental waste deposits, low-level radioactive slag, highly leachable wastes/soils, and marginally leachable soils that are present on the ground surface and in the shallow subsurface. Water quality impacts to the Moira River in this area include groundwater discharge from the Tuttle Shaft and surface water runoff from the contaminated waste rock, soils, and highly leachable wastes. In the Remote Mine Area, waste rock contains high arsenic levels; however, the impacts to water quality associated with these remote waste rock areas are considered to be insignificant relative to those occurring at the Gatling and Tuttle Shaft Area.

While it is clear from the Onsite Data Summary report (CH2M HILL, February 2002) that there are generally low levels of contaminants throughout the Mine Area, waste excavation and transport to the Industrial Area will focus on the areas of highly leachable wastes/soils and/or those of elevated risk to human or wildlife health.

During excavation and capping activities planned for the Main Mine Area, it will be necessary to minimize the destruction of existing second growth forest.

3.3.2 Miscellaneous Wastes

Solid, non-hazardous miscellaneous wastes and hazardous miscellaneous wastes will be managed onsite. Trees and brush that are removed during clearing and grubbing may contain contaminants in their tissue. A sampling program to determine the extent of tissue uptake and associated risk is required.

3.3.3 Waste Inventory

The types of wastes identified at the site were listed in Section 3.3.1. An inventory of these wastes, including their description, location, and volume, if known, was developed in previous reports and is briefly summarized below.

Main Mine Area

The leachate generated and collected from the Tuttle Shaft is expected to generate an average of 195 m^3/d or 71,175 m^3/year of flow to the ATP on a year-round basis. The current three-year average flow is 13,316 m^3/year while pumping during three to five warm weather months (see Section 3.5.3).

The former arsenic dump area north of the Gatling Shaft is about 2,000 m^2 and, assuming an excavation depth of about 1 m, is expected to produce a volume of about 2,000 m^3 of material.

Low-level radioactive slag is located west of the Tuttle Shaft. The volume of this slag is approximately 5 m^3.

The Main Mine Area surficial soil sampling locations GB3001, GB3002, GB3003, GB3004, GB3005, SS3022, SS3026, SS7030, SS7032, SS7033, SS7034, SA6, SA21, SA26, and 46 (see Figure 1-4) were identified in the draft SSRA as requiring remediation. Contaminants that exceeded GUCSO criteria include arsenic, silver, cobalt, copper, nickel, boron, lead, titanium, cadmium, mercury, and zinc. Assuming excavation to a depth of about 1 m within a 20-m radius of the soil sampling location represents about 19,600 m^3 of material.

There are three areas, as shown in Figure 1-4, that are identified as areas that may require selective consolidation and simple earth (clay) caps. The two areas adjacent to the Industrial Area are extensions of similar areas within the Industrial Area. While there are no sampling results to indicate that these areas are of concern, they are adjacent to areas of concern and should therefore be included in the same testing program as will occur in the Industrial Area. The area shown for selective consolidation and simple earth (clay) cap in the vicinity of the Gatling Shaft is considered a high likelihood area for arsenic contamination since it is downgradient of the former arsenic dump area. Therefore, soil testing should be carried out to determine if this assumption is correct or not.

From the current available data, it is not clear if waste rock, highly leachable wastes, or marginally leachable soils are within the 100-year flood elevation of the Moira River adjacent to the Main Mine Area. While this will need to be confirmed, an estimated 3,000 m^3 of material has been included in the volume required for consolidation in the Industrial Area.

Remote Mine Area

Areas identified in the draft SSRA as requiring excavation or capping are found in four general areas that are remote from each other. Contaminants that exceeded GUCSO criteria include arsenic, silver, barium, beryllium, cadmium, cobalt, nickel, lead, and molybdenum. The areas to be excavated to a depth of about 1 m are within a 20-m radius surrounding the shallow soil sampling locations SS7040, SS3002, SS3004, 56, 57, and 72 (see Figure 1-4). Excavations are expected to generate about 1,300 m^3 per location for a total of about 7,800 m^3. The actual excavation quantities will be based on reducing contaminant concentrations to acceptable risks,

including the removal of highly leachable wastes/soils, if present. Prior to all such excavations in the Main Mine Area and Remote Mine Area, a field sampling program will be required to more clearly define the extent of excavation required including width, length, and depth, since available sampling locations are generally limited (see Figure 1-4).

3.3.4 Waste Removal and Handling

The majority of the soil and waste handling will be performed using heavy equipment, namely excavators and trucks. Open excavations are considered feasible for the shallow excavations to be carried out. For the purpose of costing the excavation component for the Mine Area, the excavations are estimated to be 1.0 m in depth, even though some areas have bedrock outcroppings close to the proposed excavation sites and the depth of excavation may be less than 1.0 m. All excavation work and trenching, if necessary, will be carried out in accordance with the provincial *Regulations for Construction Projects*.

Stormwater from rainfall events, especially heavy rainfall during storms, can result in the migration of contaminated material during excavation and waste placement activities. The contaminants can be transported in eroded sediments as suspended or dissolved solids in the stormwater to nearby watercourses. Surface water protection controls will be in place to minimize sediment migration in stormwater. In addition, stormwater controls are necessary to prevent the accumulation of ponded water in work areas, which can reduce work efficiency.

Excavations will be staged such that grades permit the egress of stormwater to a catchment area or temporary retention pond to collect stormwater for sampling, sediment settling, and (depending on the water quality) release to the Moira River or the equalization pond for processing in the Arsenic Treatment Plant. Potential locations for temporary retention ponds in the Mine Area will be identified during the detailed design.

Dust, noise, surface water protection and decontamination procedures are presented in Section 4.7.

3.3.5 Waste Transportation

Waste transportation in the Mine Area (Main and Remote Mine Areas) will largely be confined to the consolidation of excavated wastes within the waste consolidation area in the Industrial Area. Worker health, community health and environmental protection will be considered in the transportation of wastes at the site.

Development of a Transportation and Emergency Response Plan (TERP) is recommended based on the requirements of each of the project areas to identify emergency contacts; emergency procedures in the event of accidents, spills, etc.; primary haul routes; truck tarping; decontamination procedures; and other issues associated with the transportation of contaminated and non-contaminated wastes/soils at the site.

Main Mine Area

Excavated material of approximately 21,600 m^3 from the former arsenic dump area north of the Gatling Shaft and from the surficial soil sampling locations, as shown in Figure 1-4, will be transported to the waste consolidation area in the Industrial Area. The low-level radioactive slag (approximately 5 m^3) will be excavated and consolidated with similar materials in the Industrial Area. Approximately 3,000 m^3 of material may be excavated from land adjacent to the Moira River and transported to the waste consolidation area.

Remote Mine Area

Excavated material from the impacted areas that include SS7040, adjacent to the Hawkeye Shaft; 72, adjacent to the Pearce Shaft; and SS3002, SS3004, 56, and 57 adjacent to and west of the Tailings Area (approximately 7,800 m^3 in total) must be hauled on Highway 7 in order to be transported to the waste consolidation area in the Industrial Area.

3.3.6 Waste Conditioning

Main Mine Area

At present, waste materials identified in the Main Mine Area will not require conditioning other than minor regrading of waste rock. Leachate from the Tuttle Shaft will be transferred to the equalization pond, and conditioning will be in the form of mixing and equalization with other contaminants and chemical precipitation in the ATP. Treatment issues regarding the leachate from the Tuttle Shaft is addressed in the Closure Plan for the Industrial Area. The need to condition wastes may arise during detailed design and will be addressed at that time.

Remote Mine Area

At present, waste materials identified in the Remote Mine Area (i.e. excavated impacted soils, highly leachable wastes if present, waste rock) will not require conditioning other than minor regrading of waste rock. The need to condition wastes may arise during detailed design and will be addressed at that time.

3.4 Waste Isolation and Containment

The conceptual remediation method that is recommended for the major portion of the Mine Area is the excavation and consolidation of the most highly leachable wastes/soils within the waste consolidation area in the Industrial Area, the construction of a 1.5-m deep simple earth (clay) cap over portions of the Main Mine Area, and a 0.65-m deep clay cap over the waste rock areas of the site.

In addition to reducing human health and ecological risks to acceptable levels, the goals of this method are to minimize:

- Contact between surface water runoff and the wastes
- Infiltration of precipitation into the wastes
- Subsequent contaminant leaching and migration to the Moira River
- Offsite migration of contaminants by wind transport

3.4.1 Design Description

Main Mine Area

- Increase pumping from Tuttle Shaft
- Cover waste rock with geofabric filter, clay, topsoil, and then vegetate
- Consolidate and cover marginally leachable soils adjacent to the Industrial Area and south of the former arsenic dump area that have unacceptable SSRA risks with a simple earth (clay) cap and then vegetate

- Excavation of low-level radioactive slag west of the Tuttle Shaft and consolidation with similar materials in the Industrial Area
- Selective consolidation of soils with unacceptable SSRA risks and highly leachable wastes (approximately 4,000 ppm arsenic and over) in the waste consolidation area in the Industrial Area below the engineered cover
- Infill with "clean" fill material and topsoil, and then vegetate

Contaminated soil overburden and fill has been categorized as either highly leachable wastes/soils with arsenic concentrations exceeding 4,000 ppm or marginally leachable soils with arsenic concentrations less than 4,000 ppm. The exception is the waste rock on the site, which contains a non-leachable, non-bioavailable form of arsenic. Therefore, the waste rock will be handled in a different manner than the highly leachable wastes and marginally leachable soils.

By increasing the pumping rate of the Tuttle Shaft from the current 13,316 m^3/year to 71,175 m^3/year and progressing to year-round pumping, the migration of deep groundwater to the Moira River will be reduced. It is predicted that this would significantly reduce current arsenic loading rates to the Moira River (*Development of a Sitewide Water and Load Balance, Final Report* [CH2M HILL, March 2002]). This will require upgrading the current pumping system for year-round operation, and directing pumped groundwater to the existing ATP via the equalization pond. The proposed alignment of the upgraded pipeline is shown on Figure 1-4.

In the waste rock areas, the waste rock will be regraded and covered with a geofabric filter. A low-permeability soil material (i.e. clay), 0.5-m thick, will be used to cover the waste rock. The compacted clay cover will be surfaced with a 0.15-m layer of topsoil to permit growth of grasses, trees, and/or shrubs. The cover design will promote runoff through slopes and swales, and reduce infiltration and deep percolation to any underlying residual material through evapotranspiration and the low-permeability clay layer. The extent of the waste rock cover layer is shown in Figure 1-4.

The area of most concentrated waste in the Mine Area is the arsenic dump north of the Gatling Shaft (CH2M HILL, July 2002). Areas of concern in the Main Mine Area that will require excavation include soil sampling locations GB3001, GB3002, GB3003, GB3004, GB3005, SS7032, SS7033, SS7034, SA6, SA21, SA26, 46, SS3026, and SS3022. Following the excavation and removal of the concentrated wastes/soils for isolation and management in the Industrial Area, the affected areas will be infilled and covered with "clean" fill material and topsoil to bring the excavated area up to grade and promote runoff (Figure 3-2). This assumes that the contaminant levels in the remaining soil in the excavated areas are acceptable from a human health and ecological perspective. If the contaminant levels are not acceptable, a minimum of 1,500 mm of depth between the bottom of the excavation and the top of the cap will be maintained, eliminating direct contact with the waste by burrowing animals or tree roots. The 150-mm layer of topsoil on the surface will permit vegetation growth of grasses, trees, and/or shrubs. The cover thickness meets the requirements as set out in the draft SSRA (CH2M HILL, May 2003a). As noted above for the waste rock areas, the cover design will promote runoff through slopes and swales, reducing infiltration and deep percolation to any underlying residual material through evapotranspiration and the low-permeability clay layer.

The areas of the Main Mine Area with marginally leachable soils, as shown in Figure 1-4, will be cleared, grubbed, regraded, and capped to establish a proper cover thickness.

The infilling of excavated areas and the methods for covering excavated areas, marginally leachable soils, and waste rock are presented in Figures 3-2, 3-3, and 3-4, respectively.

Remote Mine Area

- Cover waste rock with geofabric filter, clay, topsoil, and then vegetate
- Excavation and consolidation of soils with unacceptable SSRA risks and highly leachable wastes (approximately 4,000 ppm arsenic and over) in the waste consolidation area in the Industrial Area below the engineered cover
- Infill with "clean" fill materials and topsoil, and then vegetate

The waste rock areas in the Remote Mine Area will be regraded after access roads are cleared to each location (as required). A geofabric filter will cover the waste rock, as well as low-permeability soil material (i.e. clay) to a thickness of 0.5 m to cover these selected portions of the Remote Mine Area. The clay cover will be surfaced with a 0.15-m thick layer of topsoil to permit vegetation growth of grasses, trees, and/or shrubs. The cover design will promote runoff through slopes and swales, reducing infiltration and deep percolation to any underlying residual material through evapotranspiration and the low-permeability clay layer. Figure 1-4 shows the locations in the Remote Mine Area that contain exposed waste rock (i.e. Northwest, Northeast, and South Remote Mine Areas).

The area of the Remote Mine Area containing unacceptable SSRA risks and potentially highly leachable wastes/soils, as shown in Figure 1-4, will be cleared and grubbed, and the wastes and soils will be excavated for isolation and management in the Industrial Area. Since the bedrock is very close to the surface, the intention is to remove all soils that have unacceptable SSRA risks and all wastes/soils that are highly to marginally leachable. Excavation should also include either sweeping/vacuuming or pressure washing/ vacuuming of the bedrock surface.

Figures 3-2 and 3-4 present the cover methods for the excavated wastes/soils and the waste rock locations.

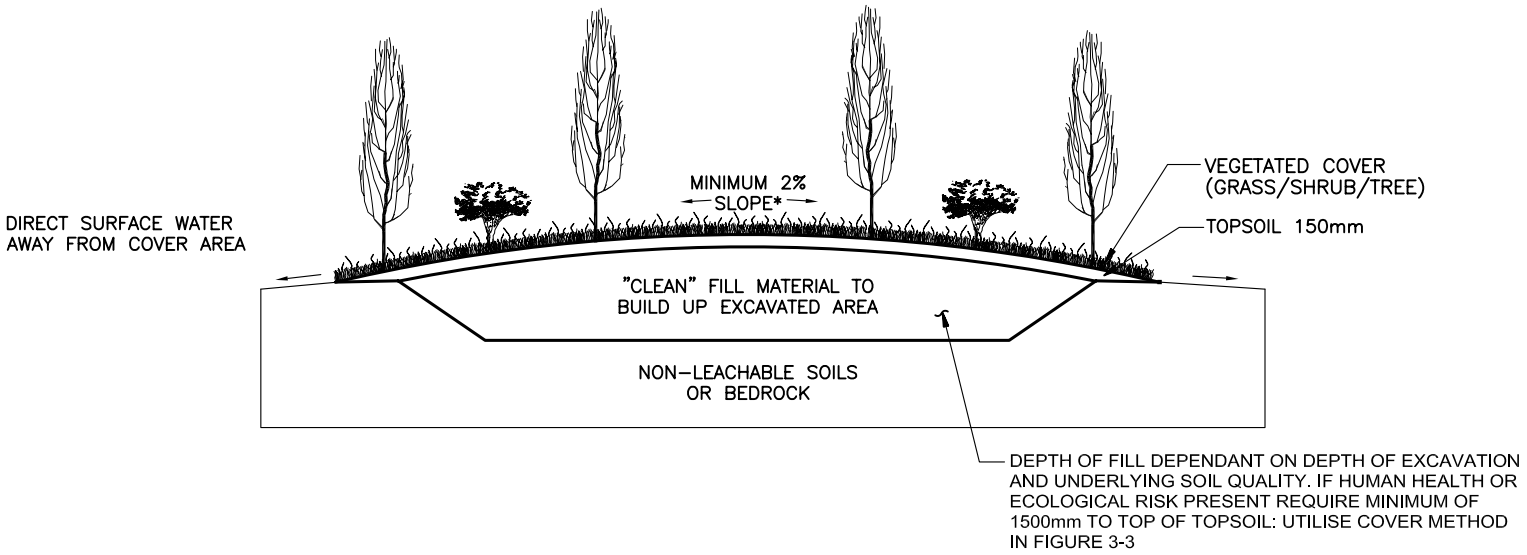
3.4.2 Material Sourcing and Haulage Routes

Main Mine Area and Remote Mine Area

Clay, sand, and other material sources are currently being identified and verified by CH2M HILL. This will be completed during the design phase following acceptance of the Closure Plan.

3.5 Water Management

Management of surface water (seeps, creeks, streams, and rivers) and stormwater from rain and snowfall, including snowmelt water, will be critical to the success of this project. Allowing water to pond on the surface or scour the soil cover could result in infiltration and/or displacement of surface soil. Steps must be taken to prevent this occurrence.



*NOTE:
SURFACE WATER TO BE CONVEYED TO MINIMIZE INFILTRATION POTENTIAL.
CLAY MUST BE COMPACTED AND MOUNDED ABOVE GRADE TO ALLOW FOR SETTLEMENT.
MUST ALSO BE CONSISTENT WITH SITE GRADES.
N.T.S.

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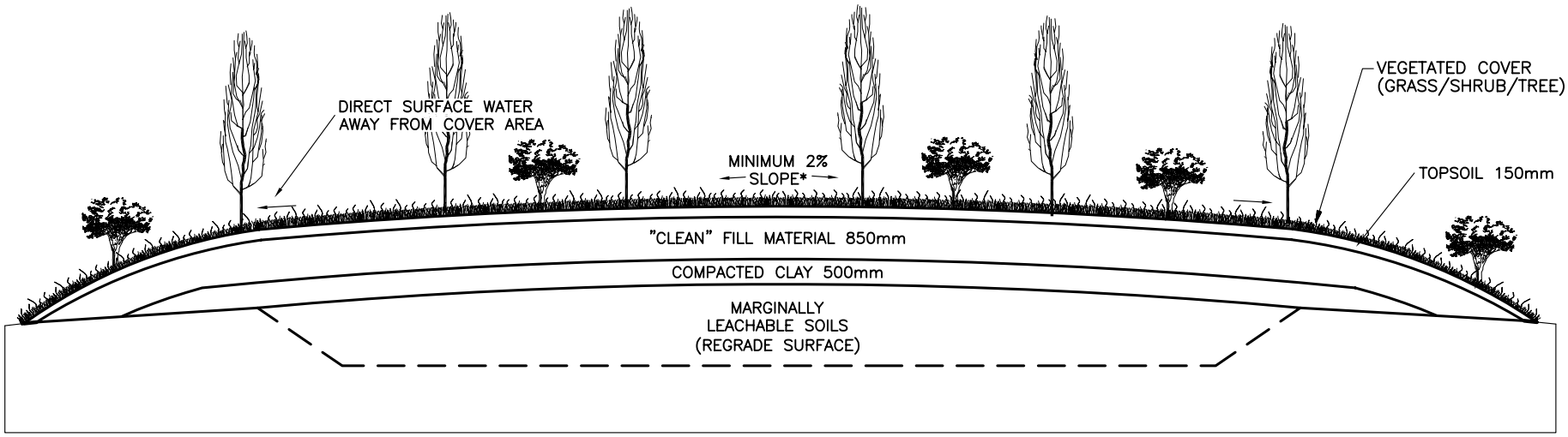
PROJECT No. 119548

REHABILITATION OF THE DELORO MINE/REFINERY SITE

FIGURE 3-2
COVER METHOD FOR EXCAVATED AREAS OF
IMPACTED SOIL AND/OR CONCENTRATED WASTE



*NOTE:
SURFACE WATER TO BE CONVEYED TO MINIMIZE INFILTRATION POTENTIAL.
CLAY MUST BE COMPACTED AND MOUNDED ABOVE GRADE TO ALLOW FOR SETTLEMENT.
MUST ALSO BE CONSISTENT WITH SITE GRADES.
N.T.S.

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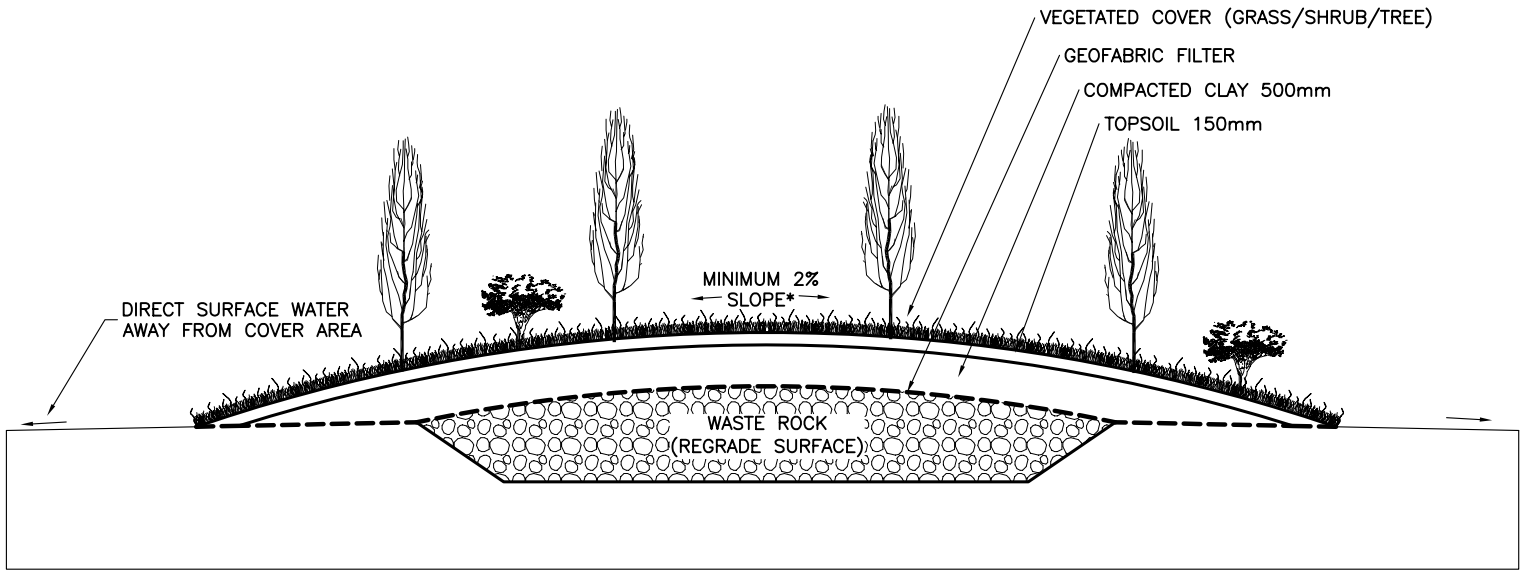
REHABILITATION OF THE DELORO MINE/REFINERY SITE

FIGURE 3-3 : COVER METHOD (SIMPLE EARTH [CLAY] CAP) FOR NON-EXCAVATED AREAS OF IMPACTED SOIL AND/OR CONCENTRATED WASTE



*NOTE:
SURFACE WATER TO BE CONVEYED TO MINIMIZE INFILTRATION POTENTIAL.
CLAY MUST BE COMPACTED AND MOUNDED ABOVE GRADE TO ALLOW FOR SETTLEMENT.
MUST ALSO BE CONSISTENT WITH SITE GRADES.
N.T.S.

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REHABILITATION OF THE DELORO MINE/REFINERY SITE

FIGURE 3-4
COVER METHOD (CLAY CAP) FOR WASTE ROCK

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3.5.1 Surface Water and Stormwater Management

Main Mine Area

Surface Water Management. Surface water from the lands west of the Red Shaft and the Gatling Shaft currently drains by way of New Westerly Creek. The surface water from the lands east of the Red Shaft, and those lands north and east of the Gatling Shaft discharge to the Moira River. The lands north of the Red Shaft and those north of the Gatling Shaft are the most heavily impacted by contaminants. The contaminants will be removed or covered as described earlier, reducing the potential impact of the contaminants on these surface waters. Temporary drainage diversion around the construction area will be required until the impacted area is fully vegetated and erosion potential is minimized.

The watercourse north of the Gatling Shaft, as shown in Figure 1-4, will need to be retained or diverted permanently after excavation of the highly leachable wastes and subsequent filling using "clean" fill material. Final location of the watercourse will depend on the extent of cover that will be required over the excavated area.

Stormwater Management. Stormwater flows will follow similar flow patterns as the surface water flow. In the weeks or months following highly leachable waste excavation and replacement with "clean" fill material, stormwater flows could erode the freshly placed soil and vegetation, and/or seeds. Snowmelt water flows could also impact the project site. Covering the newly profiled areas with erosion protection will be critical in the short term, particularly in the area north of the Gatling Shaft since there is an existing watercourse that bisects the highly leachable waste area.

Remote Mine Area

Surface Water Management. No special water management strategy is required since the surface water drainage paths are not in the immediate area impacted by the proposed excavation of wastes/soils, infilling, grading, and covering of waste rock.

Stormwater Management. Stormwater flows will follow similar flow patterns as the surface water flow. In the weeks or months following the covering of the waste rock with soil, stormwater flows, or direct precipitation could erode the freshly placed soil, vegetation, and/or seeds. Covering the newly profiled areas with erosion protection will be critical in the short term. During the excavation of highly leachable wastes in the Remote Mine Area in the areas adjacent to the Tailings Area, and after subsequent infilling, erosion protection will be required.

In order to reduce the potential of the erosion of any of the exposed soil in the Remote Mine Area, a survey of areas of open and unvegetated soil is recommended. These areas should be covered with soil (if necessary) and vegetated, providing the same level of stormwater erosion protection as noted above.

3.5.2 Groundwater Management

Main Mine Area

Groundwater protection from infiltration in areas identified to be of high contaminant loading will be completed as noted in this Closure Plan. A combination of removal of the highly leachable wastes, compaction of clay soil, contouring to promote runoff, and

encouraging dense vegetative growth to increase evapotranspiration on the restored areas will reduce infiltration and transport of contaminants into the groundwater.

Remote Mine Area

No special water management strategy is required since the potential for impacting the groundwater is remote. Groundwater protection from infiltration in the waste rock areas will be completed as noted in this Closure Plan. A combination of compaction of clay soil, contouring to promote runoff, and encouraging dense vegetative growth to increase the evapotranspiration on the restored areas will reduce infiltration. Soils that were identified as being sufficiently contaminated to be flagged by the draft SSRA will be removed, thus reducing the potential for groundwater impact.

3.5.3 Leachate Collection and Treatment

Main Mine Area

Groundwater collected in the Tuttle Shaft will be extracted on a year-round basis and treated in the onsite ATP. The Tuttle Shaft flows by gravity under artesian conditions to the Moira River, reportedly for nine months of the year. However, observations by OCWA staff have confirmed that the flow continues year-round (personal communication OCWA, March 2004). A flow rate of 135 L/min (195 m^3/d) was measured during 1997 field investigations completed by CH2M HILL (*Development of a Sitewide Water and Load Balance, Final Report*, CH2M HILL, March 2002). Based on the 195 m^3/d reference rate, the maximum possible volume per year would be on the order of 71,175 m^3, assuming water could be drawn for 12 months per year. At this time, the Tuttle Shaft pump is only operated during low-flow conditions in the Moira River, which typically extends for two to five months during the Summer and Fall. Pump operation is dependent on Moira River water quality impacts by the Tuttle Shaft discharge. Annual water taking records from OCWA from 2000 to 2003 indicate that the annual average withdrawal is 13,316 m^3/yr. Table 3.1 summarizes the Tuttle Shaft pumping rates from 2000 to 2003. OCWA indicates that the Tuttle Shaft has a FLYGT Model #2052 pump with a 1.6 hp, 220-volt motor. OCWA's annual water taking records indicate that the Tuttle Shaft pump capacity is 6.05 L/s (523 m^3/d). Accordingly, the capacity of the existing pump is anticipated to be sufficient to draw more than the quantity of water naturally flowing under artesian conditions, which would meet the requirements of the Closure Plan.

TABLE 3.1
SUMMARY OF TUTTLE SHAFT PUMPING RATES

Year	Number of Months Pumped	Months Pumped	Total Volume (m^3)	Maximum Pumping Rate (m^3/month)
2000	2	Sep., Oct.	9,916	6,649.4
2001	4	Jul., Aug., Sep., Oct.	13,730	4,412.6
2002	5	Jul., Aug., Sep., Oct., Nov.	16,720	7,557.7
2003	3	Jul., Aug., Sep.	12,900	6,671.2
Average			13,316	

Data from OCWA's Annual Record of Water Taking for the Tuttle Shaft (Pumping Station No. 6) from 2000 to 2003.

A new, more durable pump may need to be purchased and installed depending on the condition and age of the existing pump. A new pipeline from the Tuttle Shaft to the equalization pond will be mounted on an overhead pipe rack to allow easier access to the pipeline in case of leakage. This will minimize the potential for compromising the integrity of the engineered and simple earth (clay) cap in the Industrial Area, as could occur during pipe failure if the pipe were to be buried. Heat tracing will be installed onto the full length of the pipe along with insulation and cladding to prevent pipe freeze-up during colder periods. The design of this system would need to be compatible with short- and long-term requirements in the Industrial Area. The ability of the current ATP to accommodate this additional hydraulic load is addressed in the Closure Plan for the Industrial Area.

Remote Mine Area

In the Remote Mine Area, there is no provision or need for collection of groundwater as the generation of leachate with contaminants of concern has not been identified in these areas.

3.5.4 Residue and Sludge Management

Main Mine Area

Since no residue or sludge will be generated in this area, no management strategy is required. Additional sludge formed during treatment of the Tuttle Shaft water will be small. The amount of additional sludge that will be generated from the Tuttle Shaft water, as well as from other future flows to the ATP, is currently being assessed by CH2M HILL. This will be completed during the final design activities.

Remote Mine Area

Since no residue or sludge will be generated in this area, no management strategy is required.

3.6 Mine Workings, Crown Pillars, and Surface Workings

3.6.1 Main Mine Area

From 1992 to 1995, the mine workings at the site were closed in three phases. Phase 1 consisted of an engineering investigation to identify and map all mine related features. This work included ground penetrating radar to locate suspected underground workings. Phase 2 consisted of drilling and engineering analysis to determine the appropriate course of action. Phase 3 included remedial actions such as identification and construction of safe access routes for vehicles around the site, the blasting of weak crown pillars, backfilling of identified shafts, pits, stopes and adits, plugging of narrow vein stopes, and capping of selected shafts. Crown pillars which were found to be stable during the investigation were left in place, and permanent markers, based on the Universal Transverse Mercator, were erected at significant mine workings. Details regarding the Closure Plans and a summary of mine closure activities can be found in the J.D.C. Dupont report entitled *Deloro Mine Workings Closure Plan* (January 1994) and the J.G. Ritter report entitled *Deloro Mine Site Rehabilitation, Summary Report on Mine Closure Activities* (October 1995), respectively.

Generally, all mine and surface workings have been sealed, and no further work is required for closure, with the exception of continued periodic observation of the surface for evidence of subsidence.

3.6.2 Remote Mine Area

Weak crown pillars were blasted, and all mine and surface workings in the Remote Mine Area were sealed during the same period that the Main Mine Area was closed. No further work is required for closure, with the exception of continued periodic observation of the surface for evidence of subsidence.

3.7 Final Site Grading

3.7.1 Main Mine Area

About one half of the Main Mine Area could be impacted through capping and grading. Impacted areas will be graded to discourage ponding, reduce infiltration, and promote runoff.

3.7.2 Remote Mine Area

A very small percentage of the site will require grading, specifically the waste rock areas and selected areas of excavation, as noted earlier in the report. Impacted areas will be graded to discourage ponding, reduce infiltration, and promote runoff.

3.8 Site Rehabilitation and Revegetation

Following the completion of site rehabilitation measures (i.e. surface water control features, waste excavation and consolidation, cover/cap placement, site grading), the Main Mine Area and selected Remote Mine Areas will be landscaped to suit the intended final use, and seeded with a mixture of grasses in order to stabilize the surface and limit erosion. The cover/cap will also be vegetated with trees and shrubs to increase the evapotranspiration capability of the cover/cap.

3.8.1 Riverbank and Water Courses

Main Mine Area

The Moira River bank may be affected, since some of the waste rock and highly leachable waste/soil areas may extend down from the 100-year flood elevation to the river's edge (see Figure 1-4). These contaminants may need to be removed, and bank stabilization would be required.

The watercourse north of the Gatling Shaft will either be excavated and reinstated in the original position, or relocated to reduce the potential for eroding the freshly placed soil and vegetation. Bioengineering and/or erosion protection using geosynthetic fabric and/or rip rap will be required.

Remote Mine Area

Riverbank and water courses are unaffected by the closure requirements of the Remote Mine Area.

3.8.2 Waste Removal Areas

Main Mine Area and Remote Mine Area

Areas where highly leachable waste is removed will be infilled and graded such that they are incorporated into the existing contours, promoting surface water runoff. Vegetation will consist of native and clonal varieties of trees and shrubs.

3.8.3 Waste Isolation Areas

Main Mine Area

Waste isolation areas will be constructed within the Main Mine Area to cover waste rock and marginally leachable soils.

Remote Mine Area

Waste isolation areas will be constructed within the Remote Mine Area to cover waste rock.

3.8.4 Temporary Works

Temporary works for the excavation and construction efforts include the following:

- Silt fencing along the edge of watercourses
- Dam and diversion measures for watercourse north of Gatling Shaft to allow excavation of arsenic dump area
- Temporary piping to continue the flow of water from the Tuttle Shaft will be required during construction on the lands between the Tuttle Shaft and the equalization pond
- Temporary road access for areas that are currently not accessible and which require excavation, filling, and/or grading
- Dust controls for roads that will be used by haul trucks and other construction equipment
- Erosion protection for newly excavated and/or placed soil
- Staging and waste conditioning areas (if required)
- Personal Protective Equipment (PPE) decontamination and change facilities
- Decontamination/control stations
- Washpad for equipment and trucks
- Truck tarping stations
- Equipment laydown areas
- Equipment storage containers
- Office trailers

4. Implementation Plan

4.1 Identification of Work Packages

Closure of the Mine Area is best accomplished in stages that will focus on being incorporated into the overall closure schedule. The work packages identified for the Main Mine Area (MMA) and Remote Mine Area (RMA) rehabilitation program are listed in Table 4.1 below.

TABLE 4.1
IDENTIFICATION OF WORK PACKAGES

Package I.D.	Work Package Description
MMA-WP#1a	Excavation and removal of the materials at the former arsenic dump, a portion of the Moira River bank (if required), and within areas including sample locations GB3001, GB3002, GB3003, GB3004, GB3005, SS3022, SS3026, SS7030, SS7032, SS7033, SS7034, SA6, SA21, SA26 and 46, and the small volume (approximately 5 m^3) of low-level radioactive slag. Infilling of the excavations to grade with "clean" fill material, topsoil, and then vegetating, including reconstructing a portion of the Moira River bank (if required). If human health or ecological risk is present in underlying soil, those areas will require a minimum cover of 1,500 mm to top of topsoil (simple earth [clay] cap design).
RMA-WP#1b	Excavation and removal of soils within areas including SS7040, adjacent to Hawkeye Shaft; 72, adjacent to Pearce Shaft; and SS3002, SS3004, 56, and 57, adjacent to and west of the Tailings Area, followed by infilling of the excavations to grade with "clean" fill material, topsoil, and then vegetating.
MMA-WP#2a	Regrade and cover waste rock with geofabric filter; cover with clay, topsoil; then vegetate. Consolidate and cover the three suspected marginally leachable soil areas with clay, "clean" fill material, topsoil, and then vegetate. Clay to be compacted in place.
RMA-WP#2b	Regrade and cover waste rock with geofabric filter, cover with clay, "clean" fill material, topsoil, and then vegetate. Clay to be compacted in place.
MMA-WP#3	Tuttle Shaft pumping system installation: Pump, piping, overhead piping support structure, pipe insulation and heat tracing.

Note: Contaminated materials excavated as part of MMA-WP#1a and RMA-WP#1b will be transferred for consolidation in the Industrial Area and covered with an engineered cap.

4.2 Sequencing of Work Packages

It is recommended that the work packages be completed in the order presented in Table 4.1. The excavation and infilling of the contaminated areas, and covering of the waste rock in the Main Mine Area should coincide with the same activities in the Industrial Area. Changes to the pumping system and the installation of the required piping cannot occur until the lands between the Tuttle Shaft and the equalization pond have received final grading. In the Remote Mine Area, removal of highly leachable wastes and soils identified in the draft SSRA as requiring removal will provide the greatest environmental improvement effect, and infilling and grading of these areas can overlap into the RMA-WP#2b efforts.

4.3 Anticipated Construction Impacts and Mitigation Measures

Anticipated construction impacts and mitigation measures are summarized in Table 4.2.

TABLE 4.2
ANTICIPATED CONSTRUCTION IMPACTS AND MITIGATION MEASURES

Construction Impacts	Mitigation Measures
Clearing and grubbing of trees and shrubs during site preparation	Altered areas should be revegetated with native/clonal species. If possible, minimize cutting trees larger than 100 mm diameter.
Suspended particulates in air from heavy equipment/vehicles adversely affecting air quality	Dust suppression methods will be utilized on an “as needed” basis.
Vegetation removal for temporary road construction or existing road upgrades to accommodate heavy vehicles	Roads not required for the future operation, maintenance, and monitoring (OMM) of the site will be excavated, backfilled with appropriate material, and revegetated to blend in with existing cover/cap requirements.
Suspended sediment in surface water	Diversion dams/trenches and geotextile silt fencing will be used to isolate surface water flows from active excavation areas. Sediment settling/retention ponds may be required.

4.4 Implementation Schedule

An implementation schedule for the five work packages is presented in Table 4.3.

TABLE 4.3
IMPLEMENTATION SCHEDULE OF WORK PACKAGES

Package I.D.	Work Package Implementation Schedule
MMA-WP#1a	Excavation and removal of the waste materials and low-level radioactive slag; infilling of the excavations to grade with “clean” fill material and topsoil; then vegetating in Year 1, including reconstructing a portion of the Moira River bank (if required).
RMA-WP#1b	Excavation and removal of soils; infilling of the excavations to grade with “clean” fill material and topsoil; then vegetating in Year 1. (As before, a thicker 1.5-m cap may be needed.)
MMA-WP#2a	Regrading and covering of waste rock with geofabric filter; covering with clay (compacted), and topsoil; then vegetating in Years 1 and 2. Consolidating and covering the marginally leachable soil areas with clay (compacted), “clean” fill material, topsoil, and then vegetating in Years 1 and 2.
RMA-WP#2b	Regrading and covering waste rock with geofabric filter, clay (compacted), and topsoil, and then vegetating in Year 1.
MMA-WP#3	Installing pump and piping in year following the completion of the Industrial Area closure between the Tuttle Shaft and the equalization pond.

Figure 4-1 illustrates the proposed project schedule.

Figure 4-1
Proposed Project Schedule

Deloro Mine Site Cleanup, Mine Area Rehabilitation Closure Plan Implementation

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		Year 1				Year 2			
Work Package ID Number	**Description**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**
	Project Initiation								
MMA-WP#1a	**Excavation and removal of the waste materials and low-level radioactive slag; infilling of the excavations to grade with "clean" fill material and topsoil; then vegetating, including reconstructing a portion of the Moira River bank (if required).**								
RMA-WP#1b	**Excavation and removal of soils; infilling of the excavations to grade with "clean" fill material and topsoil; then vegetating**								
MMA-WP#2a	**Regrading and covering of waste rock with geofabric filter; covering with clay (compacted) and topsoil; then vegetating. Consolidating and covering the marginally leachable soil areas with clay (compacted), "clean" fill material, topsoil, and then vegetating**								
RMA-WP#2b	**Regrading and covering waste rock with geofabric filter, clay (compacted), and topsoil, and then vegetating**								
MMA-WP#3	**Install pump and overland piping in year following the completion of the Industrial Area closure between the Tuttle Shaft and the equalization pond**								

4.5 Cost Opinion for Each Work Package

A cost opinion for each work package is presented in Table 4.4. Operation, maintenance, and monitoring (OMM) costs are also provided in Table 4.4.

TABLE 4.4
ESTIMATED COSTS FOR IMPLEMENTING RECOMMENDED ALTERNATIVE

Mine Area Closure Plan

Work Package Identification Number	Description	Estimated Cost* (2004 dollars)
Capital Cost Items		
MMA-WP#1a	Excavate Highly Leachable Wastes, Radioactive Slag, and Infill/Vegetate and Reconstruct Riverbank (if required)	$1,095,000
RMA-WP#1b	Excavate Impacted Soils and Infill/Vegetate	$360,000
MMA-WP#2a	Cover Waste Rock, Consolidate/Cover Marginally Leachable Soils, and Vegetate	$531,000
RMA-WP#2b	Cover Waste Rock and Vegetate	$134,000
MMA-WP#3	Upgrade Tuttle Shaft Pumping System Installation and Install Overland Piping to Industrial Area	$73,000
Total Capital Costs		**$2,193,000**
OMM Cost Items (Average Weighted Annual Costs)		
Total Average Weighted Annual OMM Cost		**$66,430****
NPV OMM Costs		**$1,091,000*****
NPV of Capital and OMM Costs		**$3,284,000**

*All costs have been developed using 2004 pricing and do not include an escalation factor.

**Includes OMM of Tuttle Shaft pumping, maintenance of capping, and monitoring program.

***Net Present Value (NPV) of averaged weighted annual OMM costs using an effective interest rate of 5 percent, and a 20-year planning horizon.

The net present value (NPV) costs presented above are the sum of the capital cost and the net present value of the OMM costs. The annual OMM costs have been transformed to a net present value assuming an effective interest rate of 5 percent and a planning horizon of 20 years. The effective interest rate includes inflationary effects. It should be noted that OMM effort and costs would be required beyond the 20-year horizon. The 20-year period was selected based on the assumption that it is a reasonable period for budgetary planning purposes.

A cost estimate for replacement monitoring wells, associated with post-remediation groundwater monitoring, is not included in Table 4.4, since the number of groundwater monitoring locations will require further evaluation.

As shown above, the estimated capital cost for the recommended alternative is $2,193,000, and annual weighted OMM costs are $66,430. The NPV of the recommended alternative, assuming an effective interest rate of five percent and a planning horizon of 20 years, is $3,284,000.

The costs required to implement the recommended rehabilitation alternative for the Mine Area of the Deloro site were developed previously in the report entitled *Deloro Mine Site*

Cleanup – Mine Area Rehabilitation Alternatives, Final Report (CH2M HILL, October 2003a). The costing performed for the above report has been used to assign a cost estimate for each of the five work packages as shown in Table 4.1. SSRA work completed since that time has resulted in an estimated increase from approximately 4,800 m^3 to 32,405 m^3 (6.8 fold increase) in the approximate volume of contaminated materials. The costs provided in Table 4.4 have been revised to account for the increased volume of contaminated materials.

To date, suitable clay has not been confirmed locally. It has been conservatively assumed that all clay (i.e. 100 percent) will have to be imported from a non-local source, compared to 50 percent as was indicated in the Mine Area alternatives report. OMM costs have increased following a more detailed evaluation, and the costs estimated for the monitoring program were not previously presented in the Mine Area alternatives report. Also, while the need to reconstruct a portion of the Moira River bank in the Main Mine Area is not clearly defined, a cost allowance has been included in Work Package MMA-WP#1a (see Appendix A).

The capital costs presented in Table 4.1 include overhead and remote location costs, the federal Goods and Services Tax (GST), a 15 percent contingency for the capital costs, a 5 percent contingency for the OMM costs, and the cost of insurance and various construction bonds associated with the work. The costs presented are expected to have accuracy on the order of +/-25 percent. A breakdown of the estimated costs is provided in Appendix A. The major assumptions used in making this cost estimate are also provided in Appendix A. The costing in Appendix A has been completed at the preliminary design level and should be considered as a "cost opinion" to assist in budgeting. An appropriate allowance should be included in any budget planning to account for cost escalation factors for work after 2004. Costs can further be refined once the recommended alternative has been accepted and the detailed design and approach have been finalized.

4.6 Health Hazard Assessment

A document entitled *Deloro Mine Rehabilitation Project – General Health and Safety Plan (GHASP), Final Report* (CH2M HILL, January 2002) has been developed to identify the main hazards, and to provide a basis for the health and safety protocols.

The GHASP identifies the following health hazards associated with the Deloro Mine Site, that could be encountered while undertaking site inspections, site investigations, and remedial cleanup:

- Arsenic and arsenic compounds, other metals, and silica
- Radiological hazards
- Heat and cold stress
- Buried utilities
- General physical (safety) hazards
- Biological hazards
- Chemicals existing at or brought onto site

The GHASP outlines and describes appropriate procedures and protocols to effectively deal with the above hazards associated with the Deloro Mine Site. The GHASP addresses hazard evaluation and control procedures, and protocols (including action levels), personal protective equipment to be used, air monitoring protocols and specifications,

decontamination procedures and protocols, spill containment procedures, confined space entry procedures, emergency response plans, and emergency contacts.

Addenda to the GHASP will address specific work packages identified in this and the other three Closure Plans.

Radiological hazards result from radioactive slag, some tailings-like material in the Industrial Area, and sediments in the onsite Young's Creek Area contaminated by radium and uranium tailings eroded from the Tailings Area. The slag represents an external hazard from radiation fields, whereas the tailings-like material and sediments represent both external hazards due to radiation fields and internal hazards from potential ingestion and/or inhalation during the handling activities. Although ambient radiation fields in most of the work areas are expected to be below 1 μSv/h, standard radiation protection procedures as described in the GHASP will be employed to minimize doses to workers during the various remediation activities. Routine radiation field monitoring will be used to identify those areas in which radiation protection procedures must be implemented. Contamination control procedures will also be implemented as described in the GHASP. Decontamination procedures are outlined in Section 4.7.4 of this Closure Plan.

4.6.1 Main Mine Area

The health hazard to workers will be greatest during removal of the arsenic dump area wastes/soils, and the clearing and grubbing of the Main Mine Area. The regrading of the waste rock and application of the geofabric filter to the surface of the waste rock will have the next greatest level of health risk to be mitigated.

4.6.2 Remote Mine Area

The health hazard to workers will be greatest during the regrading of the waste rock and application of the geofabric filter to the surface of the waste rock.

4.7 Environmental and Community Health Protection Plan

Potential receptors that could be affected by the cleanup of the Deloro Mine Site include workers involved in the site cleanup, residents in the Village of Deloro, residents and cottagers along the Moira River downstream of the site, and vehicular traffic along Highway 7 near Young's Creek (in the case of impacted materials to be transported onsite from offsite Young's Creek across Highway 7). The following ECHPP identifies potential risks associated with the cleanup of the site and recommends appropriate mitigation measures. Protection of workers involved in the site cleanup was addressed in Section 4.6.

The disturbance of potentially contaminated materials during remedial activities and the possible loss of contaminants from the work area depend to a high degree on the remedial methods and related physical activities undertaken during site rehabilitation. Since the transport of contaminants is most easily controlled at the source, the remedial activities selected for the site have been chosen based on the ability to minimize and control the disturbance, spread, and loss of contaminants from the work area. Additional actions can be taken to further limit the spread and loss of contaminants from the work area and potentially offsite. These include measures to control dust, noise, odours, surface water runoff, surface water run-on, and erosion, as well as the use of appropriate equipment and

personnel decontamination procedures. Each of these measures, which are discussed briefly below, will be undertaken prior to and during implementation of the remedial activities. Odour control is not discussed since it is not expected to be of concern during implementation of remedial activities at the Deloro site.

It should be noted that this overview provides some of the key aspects associated with the mitigation and monitoring of potential offsite impacts resulting from remedial activities. The specific details and procedures will be included in the contract documents and specifications associated with the rehabilitation of the Deloro site, and the execution plans proposed by the remedial contractors who are selected to complete the cleanup work.

4.7.1 Dust Control and Air Monitoring

Effective dust control at sites undergoing remediation is best addressed via the development, establishment, implementation, and enforcement of a fugitive particulate emission control program. The development and implementation of such a program is generally the responsibility of the remedial contractor, and is required to be reviewed and approved by the owner and/or the consultant. The fugitive particulate emission control program includes a description of the procedures relating to the handling of materials, air monitoring and dust control, and is documented in the contractor's execution plan for the site remedial activities. The remedial contractor is required to take all precautions necessary to minimize and control the generation of dust, and under no circumstances will unacceptable levels of dust be permitted to be generated and/or transported offsite.

Key aspects of a fugitive particulate emission control program include:

- Carrying out remedial activities that involve disturbance of material, such as excavation, during good weather conditions in order to minimize the loss of materials by wind.
- Movement of materials directly to their designated location, rather than handling several times, in order to minimize the generation of dust (i.e. multiple handling tends to break materials into smaller and smaller pieces which are more likely to be entrained by wind).
- Ensuring adequate equipment and personnel are available at the site at all times to immediately clean up any spilled material, whether it be of a small or large amount.
- An inspection program to monitor the condition of onsite and offsite roads, materials piles, vehicles, etc.
- The use of tarps to cover materials which are likely to generate dust.
- The use of dust suppressants to control dust associated with roadways, work areas, stockpiles and other possible sources. Materials used to assist in dust suppression might include water, calcium chloride, or latex binders. The frequency of application of dust suppressants is generally on an as-needed basis.
- Regrading of unpaved roads, as required, to keep silt content below 10 percent, and the sweeping of paved roads.
- The use of tarps on trucks used to transport materials onsite and offsite.
- In the case of the Deloro site cleanup, air monitoring both upwind and downwind of the site will be carried out in order to confirm that dust control measures are effective, and to ensure that any potential offsite air quality impacts caused by remedial operations are

minimized. Monitoring should be carried out for dustfall and total suspended particulate matter (TSP). Monitoring for arsenic and other selected metals should also be considered. Although radioactive contaminants may become airborne in the handling of radioactive tailings, the expected levels will be considerably less restrictive than those for arsenic at similar TSP concentrations.

- The frequency of monitoring and location of monitoring stations at the Deloro site will be determined following the development of the final integrated cleanup plan and the review of the contractor's execution plan, the proposed remedial activities, and meteorological conditions. Typically, TSP is measured using standard high-volume samplers and a daily (24-hour) average determined. Depending on the size of the site, samplers are typically located at four upwind/downwind perimeter sites during each work day. Their location is subject to change based on the location of remedial activities, but they are generally placed at the furthest possible distance downwind of the site but within the property line. Standard dustfall jars are used to obtain dustfall measurements, which are typically determined based on a 30-day integrated measurement of dustfall loadings at four perimeter locations.
- Meteorological measurements (wind speed and direction) may also be required to be carried out in conjunction with the air monitoring program. Typically, hourly and daily average wind speed and direction at one localized site could be required during site activities.
- The MOE Ambient Air Quality Criteria (AAQC) for dustfall is 7 g/m^2 (30-day AAQC) and for TSP is 120 $\mu g/m^3$ (24-hr AAQC). The AAQC for TSP and dustfall were determined with nuisance effects being the limiting factor. Health effects are not a concern until TSP levels are several times higher than defined by the AAQC, unless elevated concentrations of arsenic and/or other metals are present in the dust. Levels in excess of these criteria, on the basis of property line monitoring results, are considered unacceptable. In instances where background or upwind concentrations exceed these criteria, additional contribution to the parameter is also normally considered unacceptable.
- Monitoring of ambient air quality prior to initiation of remedial activities at the Deloro site is recommended, and should be carried out on several occasions and under a variety of conditions in order to establish background air quality both onsite and offsite.

4.7.2 Noise Control

While noise is expected to be generated at the Deloro site during cleanup as a result of mobile sources such as truck and vehicular traffic, as well as equipment sources such as excavators, bulldozers, compactors, generators, pumps, and air compressors, conformation with regulatory requirements is not expected to be a major problem. The development and implementation of a noise monitoring and control program is generally the responsibility of the remedial contractor, and is required to be reviewed and approved by the owner and/or the consultant prior to initiation of any site work. The contractor is usually required to provide written details of the noise monitoring and control program in the execution plan to ensure that local requirements are met.

Typical aspects of a noise monitoring and control program include:

- The contractor will be required to take all precautions necessary to minimize noise, and under no circumstances will unacceptable levels of noise be permitted to impact offsite residents/property owners.
- The contractor is to conduct all work using appropriate construction methods and equipment so that noise emanating from the site remains at acceptable levels.
- The contractor is required to obtain approval from the owner and/or consultant prior to conducting any site activities between the hours of 6:00 p.m. and 7:00 a.m.
- The contractor will be required to undertake noise monitoring if deemed necessary.
- MOE noise guidelines for landfill operations suggest that a criterion of 50 dBA during the hours of 7:00 a.m. and 7:00 p.m. should be established for the closest residential location. A similar guideline may be suitable for the cleanup activities at the Deloro site.

4.7.3 Surface Water Protection

The control of surface water is required in order to minimize the contact of water with potentially contaminated materials, and thus reduce the generation of contaminated water. This can be achieved though the control of surface water runoff from the work area, as well as the control of surface water run-on into the work area. Surface water is also required to be controlled in order to minimize erosion, and prevent the offsite transport of potentially contaminated water and sediment to Young's Creek and the Moira River. Specific details relating to the control of surface water will be dependent on the final engineering designs for the cleanup of the site.

The development and implementation of a work area surface water control program is generally the responsibility of the remedial contractor, and is required to be reviewed and approved by the owner and/or the consultant. Generally, the remedial contractor is required to take all precautions necessary to minimize the generation of sediment and potentially contaminated surface water, and may be required to collect and treat any such water.

Key aspects of a work area surface water control program include:

- The use of geotextile silt fencing, sand bags, and/or straw bales to reduce sediment transport.
- The construction of surface water diversions, comprised of swales and sumps, or clay berms, to re-direct and/or collect surface water runoff and run-on.
- The collection and treatment of all potentially contaminated water, including water used to decontaminate equipment, surface water, and water generated from the dewatering of excavations.
- In the case of the Deloro site cleanup, surface runoff characteristics (i.e. quantity, quality, and direction of flow) of the site should be assessed prior to initiation of remedial activities. Additionally, an assessment of the quality of water in existing site drainage ditches and channels, including those that result in both run-on and runoff, standing water, and natural water (i.e. any adjacent natural streams, wetland areas, and the Moira River) should be undertaken prior to remedial activities (if not addressed through current site monitoring). The water quality assessment should include the sampling and analysis of water for total suspended solids, arsenic, and metals.

- Once a decision on the activities planned for the Deloro site is made, a site-wide surface water quality monitoring program should be developed for implementation during the cleanup.

4.7.4 Decontamination Procedures

In order to prevent the transfer of contaminants from the work area, all equipment, materials, and supplies that come into contact with potentially contaminated materials must be decontaminated prior to removal from the work area. The development and implementation of equipment decontamination procedures is generally the responsibility of the remedial contractor, and is required to be reviewed and approved by the owner and/or the consultant. The remedial contractor is required to take all precautions necessary to minimize the transfer of contaminated materials from the work area. Under no circumstances is the transfer of non-decontaminated equipment and materials from the work area permitted.

The key aspects of a decontamination program include:

- Decontamination of equipment and materials that have come into contact with potentially contaminated materials, completed by the contractor prior to the removal of equipment and materials from the work area.
- Equipment decontamination using water or steam facilities to decontaminate tracks, sprockets, tires, axles, buckets, and trailers used in the transport of materials.

CH2M HILL has prepared a conceptual design for a decontamination facility to be constructed and operated by the remedial contractors.

4.7.5 Emergency Response and Preparedness

CH2M HILL will develop a site-specific emergency procedures plan, including requirements and information relating to emergency contacts; directions to the nearest hospital; spill and fire control; emergency communications, notification, and reporting; and emergency response such as for a spill, fire, or medical emergency. All site contractors will be expected to be familiar with and implement the site-specific emergency procedures plan as required. Much of this information is already contained in the GHASP (CH2M HILL, January 2002).

4.7.6 Associated Considerations and Activities

Several issues associated with the mitigation of offsite impacts include:

- CH2M HILL will develop a site TERP to outline procedures and protocols for addressing vehicular accidents and spills of hazardous and non-hazardous materials. Procedural controls will limit the speed of vehicles and determine safe routes.
- The development and implementation of specific work practices associated with contamination, decontamination, and clean work zones.
- In addition to the existing perimeter fencing, the development and implementation of a site security plan including aspects such as additional fencing of work areas, warning/caution signs, security patrols, control of site staff and visitors, etc.

- The use of a qualified environmental contractor that is experienced in similar types of projects, has a good safety and environmental record, and whose employees are experienced and qualified.

4.8 Other Operational Procedures

4.8.1 Main Mine Area

Other operational procedures are associated with the operation of the ATP in the Industrial Area. As detailed in Section 3, contaminated groundwater collected at the Tuttle Shaft (Main Mine Area) will be pumped to the equalization pond for treatment at the onsite ATP. The operational procedures associated with the ATP are contained in the Closure Plan for the Industrial Area.

No other operational procedures are anticipated.

4.8.2 Remote Mine Area

No other operational procedures are anticipated.

5. Operation and Maintenance Requirements

Operations and maintenance efforts under the recommended alternative would be associated primarily with the groundwater collection, pumping, and conveyance system at the Tuttle Shaft, periodic maintenance of the earth caps and the reconstructed riverbank (if applicable) to repair any erosion damage and areas of vegetative stress, and perimeter fence maintenance. In addition, infilling of the surface of previously sealed mine workings may be required if subsidence is found.

A detailed operations and maintenance plan should be established for the Mine Area following implementation. Operations and maintenance of the control measures will be required to ensure that they remain in good working order.

5.1 Groundwater Collection, Pumping, and Conveyance System

OMM efforts for the groundwater collection, pumping, and conveyance system at the Tuttle Shaft include the following:

- Pump inspection and maintenance on a routine basis as recommended by the pump manufacturer (e.g. routine seals replacement)
- Pump flow capacity testing
- Flow meter calibration annually
- Pipe integrity testing (pressure testing)
- The monitoring of pump operations and pipe integrity, including pressure testing may be as frequent as weekly if no alarms are in place, and could be monthly if alarms are in place and tested regularly
- OMM related to the ATP are covered in the Closure Plan for the Industrial Area.

5.2 Cap/Cover and Riverbank

Maintenance efforts will include periodic maintenance of the earth caps and reconstructed riverbank (if applicable) to repair any erosion damage and areas of vegetative stress. In the short-term of the first three years, this will include watering of the planted areas, plant growth monitoring, plant replacement as required, and checking for tree health and addressing rodent activity (beaver and vole controls). If trees are planted, mowing between tree rows will help reduce competition from grasses and expose rodents to predators. These activities will help to reduce the mortality rate of the freshly vegetated areas, and to improve the likelihood that the vegetation density increases to the required level.

As the trees mature, occasional sampling of the leaf and bark tissue for contaminants of concern may be required if subsurface soil conditions warrant. The long-term monitoring will be less frequent than the short-term monitoring. Plant growth monitoring will be used

to determine seasonal trends, and ascertain whether replacement is required. Monitoring for beaver and vole activities, and implementing controls will be required if the plantation integrity may be compromised.

5.3 Perimeter Fencing

A maintenance program to inspect and maintain the integrity of the perimeter fence will address the following activities on a semi-annual basis in spring and fall:

- Removal of dead trees that may otherwise collapse and damage the perimeter fence
- Removal of beaver dams which are creating surface water control problems, including follow-up inspections to ensure they are not reconstructed
- Routine inspections to identify any other problems with the fence integrity, such as missing or damaged signs

The MNR should be contacted in the event large mammals become trapped inside the perimeter fence, to determine a suitable course of action.

5.4 Mine Workings

As noted in Section 3.6, the mine workings in the Main Mine Area and the Remote Mine Area were closed in three phases from 1992 to 1995. Generally, all mine and surface workings have been sealed, and no further work is required for closure with the exception of continued periodic observation of the surface for evidence of subsidence. If subsidence is detected, some infilling of the surface of the former mine workings may be required.

6. Monitoring Program

A comprehensive monitoring plan will be required to evaluate the effectiveness of the remediation measures and controls, and to identify the need for maintenance tasks discussed in Section 5.

The current site-wide monitoring program (surface water, groundwater, pumping system, ATP inlet and outlet) will be extended to monitor site conditions and the effectiveness of the site rehabilitation measures. This will include the existing monitoring wells, the surface water sampling stations, and the operational sampling stations, as well as time domain reflectometry (TDR) measurements of the cover and cap elements. Provided that the monitoring confirms the effectiveness of the closure measures in reducing the flux of arsenic reaching the Moira River, the frequency of the sampling may be gradually reduced.

Periodic monitoring is anticipated to be required during the following two phases:

- Phase 1: Post-Construction Performance Assessment – to assess the effectiveness of the cleanup measures and controls, and to evaluate the remaining potential exposure pathways and whether or not these are significant
- Phase 2: Long-Term Monitoring and Maintenance – repairs to covers, maintenance of Tuttle Shaft groundwater collection and conveyance system, cover vegetation care, etc.

Monitoring programs that will likely be prescribed for the Mine Area are summarized in Table 6.1.

TABLE 6.1
MONITORING PROGRAM

Type of Monitoring	Description	Duration	Frequency
Physical Stability	Visual inspection of surface of sealed mine workings, vegetative cover, erosion problems, tension cracks, seeps	Indefinitely following capping (Note: Inspection of surface of sealed mine workings for subsidence is ongoing, following closure of mine workings during 1992 to 1995)	Semi-annual for Years 0 to 3 Annual after Year 3
Water Quality	Sampling and analysis of surface water at key selected locations	During the excavation stage of the project	Daily during excavation
Water Quality	Sampling and analysis of surface water at key selected locations	Indefinitely following capping	Semi-annual for Years 0 to 5 Annual after Year 5
Leachate Quality	Sampling and analysis of leachate at Tuttle Shaft	Indefinitely following capping	Semi-annual for Years 0 to 5 Annual after Year 5
Pumping and Conveyance	Visual inspections and pressure testing	Throughout the pumping period	Monthly (with alarms in place)
Biomonitoring	Vegetation tissue sampling, soil moisture monitoring, visual observations	Indefinitely following capping	Annually for Years 0 to 5 Once every five years for the next 20 years Once every 10 years thereafter
ATP Influent/ Effluent Quality	Sampling and analysis of influent/effluent from the ATP	Refer to the Closure Plan for the Industrial Area	Refer to the Closure Plan for the Industrial Area

The results of monitoring during closure activities should be documented in annual monitoring reports. During the post-closure period, annual reports should be prepared that document the results of monitoring activities for that year, discuss past trends in the data, and forecast trends for the future. The overall effectiveness of the cleanup measures and controls should be examined.

The various components associated with the monitoring program are described in detail below.

6.1 Physical Stability

During construction of the clay covers/caps, compaction testing will be undertaken to verify compliance with the compaction standards described in the specifications, in order to reduce infiltration potential. After construction has been completed, the covers/caps will be inspected for erosion and slumping.

Long-term monitoring of the physical stability of the earth caps will be required. Physical monitoring of the covers/caps will include evaluation of surface water erosion damage, vegetative stress, tension cracks at the crest of slopes, and seepage along the side slopes. Semi-annual physical stability monitoring is recommended for the first three years after the vegetative covers have been planted. When the vegetative covers have become well established, annual monitoring is recommended.

As noted in Section 3.6, all mine workings at the site were previously identified and sealed in the Main Mine Area and Remote Mine Area. Periodic observation of the surface of these former mine workings will be required for evidence of subsidence.

6.2 Chemical Stability and Water Quality

An extensive program is in place to monitor surface water and groundwater quality at the Deloro site. The program includes the monitoring of the ATP influent and effluent, and the groundwater pumping stations in the Industrial Area. Two monitoring networks on the Moira River and Young's Creek provide information on surface water quality, and a series of monitoring wells on the site property assess groundwater levels and quality.

Future chemical stability and water quality monitoring efforts will be focussed on the monitoring of the ATP influent and effluent, surface water, groundwater, and possibly sediment quality at selected locations to evaluate the effectiveness of the recommended alternative following implementation.

Some of the existing monitoring wells in the Mine Area may need to be decommissioned prior to construction. New groundwater monitoring wells may need to be installed at selected locations to undertake post-remediation groundwater monitoring.

The surface water sampling locations associated with the Mine Area will be selected as part of a site-wide monitoring program to evaluate the improvement in water quality in the Moira River. The post-remediation surface water sampling locations are anticipated to be similar to the existing monitoring network on the Moira River. This will allow comparison of post-remediation water quality data with (historical) data currently being collected by OCWA.

Testing of groundwater from the Tuttle Shaft groundwater collection well (i.e. sample collection, analysis, recording, plotting), recording of flow rates, groundwater level monitoring, and alarm testing will be required to track changes in each of these components over time, and to predict their impact on the ATP.

During the rehabilitation stage, monitoring will be required for surface water and sediment quality to assess the impacts on surface water quality during excavation and consolidation activities. The purpose of the surface water quality monitoring will be to assess the effectiveness of surface water quality protective measures that are implemented during excavation activities. During periods of active excavation work onsite, surface water samples should be collected on a daily basis, and analyzed for arsenic, metals, and suspended solids. As a minimum, samples should be collected at sampling station #9, the New Westerly Creek Station at the Moira River, and at any stormwater retention ponds used to settle suspended solids. The results should be compared to historical pre-excavation concentrations as well as PWQOs.

Monitoring of surface water and sediment quality will be required prior to, and following riverbank reconstruction activities (if required) to confirm whether reconstruction activities have affected the Moira River surface water or sediment quality. Samples will be analyzed for arsenic and metals of concern including cobalt, copper, and nickel.

Semi-annual monitoring of surface water quality at the selected locations is recommended initially for the first five years following completion of the Mine Area rehabilitation activities. Provided that the results do not indicate any adverse impacts on surface water quality, the monitoring frequency would be reduced to annually following the initial five years.

6.3 Seepage and Groundwater Collection, Pumping, and Conveyance System

The monitoring of the Tuttle Shaft groundwater pumping operations will be necessary to ensure that the required pumping rate and the pipe integrity are maintained. Monitoring will include pressure testing that may be as frequent as weekly if no alarms are in place, and could be monthly if alarms are in place and tested regularly.

6.4 Biomonitoring

Biomonitoring will be undertaken in areas where natural environmental restoration measures are planned. This includes the revegetation of the capped and covered areas within the Main and Remote Mine Areas. The biomonitoring program will be undertaken during the first growing season following the construction of each remediated area, and annually thereafter for a total of five years. Biomonitoring will then be conducted once every five years over a 20-year period, and every 10 years thereafter.

Qualified field personnel will evaluate the success of herbaceous vegetation such as grasses, wildflowers, seeding, and woody plantings in the remediated areas. Plant health will be monitored, and woody planted materials, such as shrubs and trees, that are inadequate or dead will be replaced. Native colonizing species of shrubs and trees that germinate and grow in these areas will also be documented.

To further support the goals and objectives of the Mine Area Closure Plan, the monitoring program may include the collection of plants (leaves and/or stems) from the capped and covered areas during the growing season and prior to senescence. The concentration of metals of concern in the plant tissues could be chemically determined. Trends could be identified, and comparisons to benchmark, toxicological, and site data could be conducted to ensure that the goals of the Mine Area Closure Plan are being met.

Wildlife use, including direct sightings or signs such as tracks, burrows, dens, nests, and scat, in the Mine Area should be documented and recorded on a site map, as one of the goals of the Mine Area Closure Plan is to increase the quantity and quality of wildlife habitat and wildlife diversity. Wildlife observations could be documented by qualified field personnel while undertaking the other investigations, and thus would be completed with the same frequency and over the same period of time as noted above.

6.5 Site Management

It is anticipated that the following site management actions will be implemented or maintained:

- Fencing exists on the perimeter of the Deloro Mine Site and access is restricted to authorized personnel.
- Signage exists on the perimeter fence as well as at the north and south approaches along the Moira River.
- The MOE will retain ownership and control of the site for the foreseeable future.
- Site conditions will be registered on title at the conclusion of the cleanup coincident with the issuance of a Record of Site Condition (RSC).

7. Malfunctions, Accidents, and Mitigation Measures

During the implementation and operation of the rehabilitative measures at the site, there is a potential that malfunctions (i.e. in design, construction, or commissioning) or accidents (i.e. due to acts of nature) could occur. These malfunctions and accidents can adversely affect remediation activities, and OMM activities, resulting in delays and costly mitigation measures. These events must be considered, and mitigation measures must be developed, to ensure environmental impacts are minimal and acceptable.

Table 7.1 identifies mitigation measures for potential malfunctions and accidents that have a reasonable probability of occurring at the site during three time frames:

- Short-term: Preparation activities
- Mid-term: Remediation activities
- Long-term: OMM activities

Table 7.1 documents potential malfunctions and accidents, as well as mitigation measures and responses.

TABLE 7.1
MALFUNCTIONS, ACCIDENTS, AND MITIGATION MEASURES IN THE MINE AREA

Malfunction (M) or Accident (A)	Mitigation Measures
Short-term: Preparation Activities	
A – Spill of contaminated soil from construction equipment/ vehicle fuel	Construction contractors and other site personnel should be trained to respond to spills. Spill would be isolated and transferred to waste consolidation area, or to an acceptable waste receiver if spill occurs offsite.
Mid-term: Remediation Activities	
M/A – During excavation and consolidation activities, severe storm events could expose contaminants, or transport contaminants via wind or stormwater	Contain stormwater (if possible) and ensure that sediment controls are in place. Implement contingency plan to dewater ponded water in excavations. Sedimentation catchments will be in place during construction activities. Excavation should be staged such that contaminated sediments cannot be washed into clean areas. These design measures should be sufficient during normal storm events. Sequence work to avoid areas subject to erosion during severe storm events.
M/A – During cap/cover construction, soil and vegetation could wash away	Placing straw onto sloped areas that are freshly planted, and planting with annual rye or wheat will help stabilize the soil. If soil is washed away, then replace the soil, and replant.
A – Damage to existing Tuttle Shaft collection system during construction activities	Repair or replace damaged components.
M/A – Perpetual disruptive forces (MNDM, 1995)	The recommended alternative for the rehabilitation of the Mine Area incorporates measures to mitigate perpetual disruptive forces. Further refinements will be addressed during detailed design.
A – Spill of contaminated soil from construction	Construction contractors and other site personnel should be trained to

TABLE 7.1
MALFUNCTIONS, ACCIDENTS, AND MITIGATION MEASURES IN THE MINE AREA

Malfunction (M) or Accident (A)	Mitigation Measures
equipment/vehicle fuel	respond to spills. Spill would be isolated and transferred to waste consolidation area, or to an acceptable waste receiver if spill occurs offsite.
M – Breach of cover/cap	Although the thickness of the covers/caps is designed to prevent penetration from tree roots and burrowing animals, there is a remote possibility that this can happen. Ongoing monitoring program will identify need for repairs to covers and caps. The site OMM manual will provide cap/cover repair procedures and protocols.
M – Riverbank erosion	Ongoing monitoring program will identify need for repairs to riverbank. The site OMM manual will provide riverbank repair procedures and protocols.
M – Tree mortality due to soil conditions, contaminants, rodents, etc.	Install raptor perches to encourage hawks and owls to prey on rodents. Routinely monitor the health of the trees. Mulch trees, keep grass mowed to reduce potential for rodent damage. If mortality occurs, determine cause of mortality (soil conditions, contaminants, rodents) and rectify, then replace trees.
M – Tuttle Shaft transfer pump failure	Use standby pump. Routine monitoring of pump performance.
M – Tuttle Shaft transfer pump or conveyance system capacity insufficient	Purchase appropriate pump and replace original pump, or increase pipe capacity by replacing with increased diameter piping or adding a parallel pipeline.
M – Flow meter producing no or erroneous signal	Repair flow meter and/or check the pump integrity.
M – Piping failure	Install auto shutoff that is triggered if back pressure is too low. Routinely monitor the pipe integrity.
M – Piping frozen	Shut down pump and thaw line. Check heat tracing integrity. Routinely monitor that the collected water is flowing.
M – Electrical short circuiting in pump control/flow meter panel	Troubleshoot and repair. If due to rain/moisture, ensure waterproof features are in place.
Long-term: Operation, Maintenance, and Monitoring Activities	
M/A – Perpetual disruptive forces (MNDM, 1995)	The recommended alternative for the rehabilitation of the Mine Area incorporates measures to mitigate perpetual disruptive forces. Further refinements will be addressed during detailed design.
M – Cover Failure due to flooding	Since the majority of the cover is from 7 to 12 m above the floodplain of the 100-year flood, the possibility of severe flooding that could potentially compromise the integrity of the cover and lead to the release of some of the contained contaminants is considered remote.
A – Seismic occurrences	Design long-term structures at the Deloro site to the appropriate Seismic Zone. The probability of an earthquake of sufficient magnitude to breach the covers is very small given the stability of the region (Zone 1, low risk of earthquake). Any damaged areas during such an event would be identified and rectified using defined maintenance procedures.

Notes: Perpetual disruptive forces are defined in MNDM (1995) to include wind erosion; water erosion due to flooding, sheeting, rilling, and gulleying; sedimentation and debris accumulation; annual ice accumulation; seasonal frost penetration; soil restructuring; and physical and chemical weathering. Biological activities include root penetration, burrowing, intrusion, and actions by animals and man.

8. Expected Post-Closure Conditions and Uses

This section provides an assessment and description of the expected conditions and uses following closure activities.

8.1 Land Use

The final intended use of the site will be specified as a component of the federal EA. It is anticipated that access to the site will continue to be restricted, and the fence that currently surrounds the site will be maintained for the foreseeable future.

8.2 Topography

The revised topography in the Mine Area (Main Mine and Remote Mine Areas) will be heavily dependent on:

- The amount of highly leachable wastes/soils excavated from areas
- The final grade of the land, which will be suitable for stormwater runoff yet allow minimal stormwater erosion
- The thickness of the earth cap applied to the remediated areas

It is anticipated that the earth cap will rise to an elevation of about 215 metres above sea level (masl) in the area north of the Gatling Shaft. The maximum elevation difference is approximately 1.5 m higher than the current grade in the Main Mine Area and about 0.65 m in the Remote Mine Area. These are well below the localized topographic high points of other locations within the Mine Area.

Public visual impacts associated with the Mine Area closure are anticipated to be minimal, principally due to the remote location and the restriction of access to the site by the public. Tree removal in the Main Mine Area may have the greatest visual impact for canoeists travelling along the Moira River during the limited high water periods.

8.3 Water Resources

It is anticipated that the implementation of the recommended rehabilitation alternative for the Main Mine Area will result in a marked improvement to the Moira River water quality, and support the overall closure objective of a 90 percent reduction in arsenic discharge to the Moira River, thus achieving PWQOs at the intersection of the Moira River and Highway 7 (CG&S, October 1998).

8.4 Plant and Animal Life

As noted in Section 2.1.2, the post-closure risks to ecological receptors from the draft SLERA are not conclusive given information that is currently available. Additional site information is being collected and further risk evaluation is underway.

9. Approval Requirements

The primary site-wide regulatory approvals that must be applied for and issued by the appropriate government agencies are outlined in this section of the Closure Plan.

9.1 Site-Specific Risk Assessment

SSRA is the remedial approach selected from the options available in the *Guideline for Use at Contaminated Sites in Ontario* (MOE, 1997). There are a number of steps to approval of an SSRA to ensure that public health and the environment are protected. First, an SSRA is reviewed by an independent third party peer reviewer who is qualified and experienced in conducting SSRAs. Once the peer reviewer's comments have been incorporated, the SSRA is submitted to the Standards Development Branch (SDB) of the MOE, which undertakes a review of both technical and policy issues. Other prerequisites for acceptance of the SSRA include community-based public communication and dialogue with the municipality regarding the SSRA. Once these steps have been completed, the cleanup can proceed.

As confirmation that the actual cleanup is completed according to the SSRA, a Record of Site Condition (RSC) will be prepared and filed to document the cleanup. The RSC is completed jointly be the proponent, MOE, as well as the consultant overseeing the cleanup. The SSRA is a Level 2 Risk Management involving the use of engineered controls (i.e. engineered covers, groundwater pumping/treatment systems). A Level 2 Risk Management requires Registration on Title for the property to document the conditions of the land in the public domain. Registration on Title will be accomplished through filing a Certificate of Prohibition.

As a result of the different land ownership between the Deloro Mine Site and the Young's Creek Area south of Highway 7, a separate SSRA report has been prepared for each of these two land parcels (see Section 2.1) following the process described in this section.

The current process for completing SSRAs, outlined above, was developed in 1997 and has been in place since that time. New legislation has been passed that is anticipated to modify this process once the enabling regulations are finalized. The new legislation, the *Brownfield Law Statutes Amendment Act*, received Royal Assent on November 21, 2001. The public comment period for the regulations ended on April 29, 2003. Final regulations, which are expected to be released through 2003, may change the SSRA process from a guideline-driven to a regulatory-driven process. The draft regulations do not suggest significant change in the technical approach to SSRAs, but they do indicate some changes in the administrative aspects. The Deloro Mine Site SSRA will be adapted, if needed, to meet the new regulatory requirements.

9.2 MOE Authorizations

Under the *Environmental Protection Act* (EPA) and the *Ontario Water Resources Act* (OWRA), approval is required from the MOE for processes that emit to the environment, or for waste management activities. The primary means of approval is through issuance of a Certificate

of Approval (C of A) for air or water emissions, or a Provisional Certificate of Approval (PC of A) for waste related activities. A Permit to Take Water (PTTW) is required for water extraction above 50,000 L/day. Generator Registration is required for ongoing waste generation, such as the ferric arsenate sludge, which is generated by the onsite ATP.

A number of MOE authorizations already exist at the Deloro Mine Site as a result of environmental mitigation actions implemented to date. This includes extraction and pumping of impacted groundwater, treatment of water in the Arsenic Treatment Plant (ATP), discharge of the treated effluent, and storage/dewatering of sludge from the treatment process. A listing of the MOE authorizations currently in place at the Deloro Mine Site is provided in Table 9.1.

The Closure Plans will result in changes to the currently authorized systems, plus the addition of new systems. Changes to the current systems will require modifications to the existing MOE authorizations, most likely through an amendment (i.e. C of A Amendment). New systems will require new authorizations to be developed.

Certificate of Approval – Sewage

Amendment to the existing C of A for the ATP, sludge storage lagoon, pumping stations, and forcemains may be required to accommodate modifications to these systems as a result of the Closure Plans.

Certificate of Approval – Air

There is no anticipated requirement for modification of the existing C of As, or for new C of As as a result of the Closure Plans.

Permit to Take Water

The existing PTTW for the Tuttle Shaft and pumping station will require amendment to account for installation of a permanent forcemain, and the increase in pumping to a year-round operation. Other PTTWs for the other pumping stations may also require some modifications.

In the Industrial Area, a new PTTW will be required to authorize the construction and operation of a groundwater interceptor system at the western property line. Similarly, a new PTTW will be needed in the Tailings Area for groundwater pumping from wells located in the vicinity of the tailings dams walls.

Provisional Certificate of Approval – Waste Disposal

The site cleanup is following the SSRA process (outlined above) where existing residuals and by-products will be managed onsite through a Level 2 Risk Management involving isolation and containment. Although the legacy materials being managed have been in place for several decades and are not the result of ongoing waste production, and many of the materials are the result of mining activities (i.e. mill tailings from a mine) that are exempt from Ontario's Waste Management Regulation, the MOE has committed to seeking a PC of A for the proposed waste management facilities under Part V of the EPA. The development of Closure Plans for the Deloro site has drawn on landfill design standards, as well as mine closure and other guidelines, as general guidance and best management practices to ensure that the site is engineered and maintained to be safe and secure for hundreds of years.

TABLE 9.1
EXISTING MOE AUTHORIZATIONS FOR THE DELORO MINE SITE

Authorization	Type	Number	Date	Description
Certificate of Approval	Sewage	4-036-82-006	28 Jul 1982	Collection/storage/treatment system
Certificate of Approval	Air	8-4042-82-006	8 Sep 1982	Lime silo venting and fume hood exhaust
Certificate of Approval	Sewage	4-053-83-006	18 Jul 1983	Pumping station and forcemain
Provisional Certificate of Approval	Waste Disposal Site	A362106	6 Sep 1983	Temporary storage processed sludge
Permit	Permit to Take Water	85-P-4006	26 Apr 1985	Tuttle shaft and pumping station #5
Certificate of Approval	Sewage	4-041-85-006	25 Jul 1985	Sludge drying lagoon
Permit	Permit to Take Water	85-P-4038	16 Aug 1985	Moira River
Certificate of Approval	Sewage	4-067-85-006	16 Sep 1985	Manhole rehabilitation
Certificate of Approval	Air	8-4069-86-006	17 Nov 1986	Plant exhaust system
Certificate of Approval	Sewage	4-116-86-876	8 Jul 1987	Tuttle shaft pump and forcemain
Certificate of Approval	Sewage	4-0155-87-006	20 Nov 1987	Sludge testing lagoon
Certificate of Approval	Air	8-4120-88-006	12 Dec 1988	Lab equipment exhaust
Generator Registration	Waste Streams	ONO199886	23 Jan 1989	Arsenic compounds and oils
Certificate of Approval	Air	8-4128-89-006	4 Dec 1989	Lab fume hood exhaust
Permit Amendment	Permit to Take Water	83-P-4010	6 Jun 1990	Pumping station #3
Permit Amendment	Permit to Take Water	82-P-4035	6 Jun 1990	Pumping stations #1, #2, and #4
Certificate of Approval Amendment	Industrial Sewage	4-041-85-006	27 Nov 1992	Sludge storage lagoon expansion
Permit Amendment	Permit to Take Water	85-P-4006	21 Feb 1996	Tuttle shaft and pumping station #5
Certificate of Approval Amendment	Industrial Sewage Works	4-036-82-006	20 Apr 2000	Decontamination facilities
Generator Re-registration (HWIN)	Waste Streams	ONO199886	Jan 2002	Ferric arsenate sludge
Provisional Certificate of Approval	Waste Disposal Site	2668-5DHJEW	30 Aug 2002	Temporary storage contaminated soil
Provisional Certificate of Approval Amendment	Waste Disposal Site	2668-5DHJEW	12 Nov 2002	Contingency plan

The Deloro Mine Site Cleanup Project is being carried out under an exemption to the provincial *Environmental Assessment Act* (EAA). Ontario Regulation 577/98 (O. Reg 577/98) exempts the Deloro Mine Site Cleanup Project from a mandatory hearing under Part V of the EPA (Sections 30 and 32).

9.3 Conservation Authority

Through the Fill, Construction, and Alteration to Waterways Regulation, which is administered in support of Section 28 of the *Conservation Authorities Act* of Ontario, the Conservation Authority regulates and may prohibit work taking place within valley, river, stream, and watercourse corridors as well as along lake waterfronts.

Fill regulations allow the Authority to prohibit or regulate the placing, excavation, grading, or dumping of fill of any kind for projects such as pools, ponds, roads, and driveways. These regulations are applied when, in the opinion of the Authority, the control of flooding, pollution, or the conservation of land within its jurisdiction may be affected by the placing or dumping of fill.

Construction regulations allow the Conservation Authority to regulate construction structure in or on a wetland or floodplain, or in any area susceptible to flooding during a regional storm. In this regulation, construction refers to new buildings, additions to existing buildings, stormwater outfalls, culverts, and bridges.

The alteration to waterways regulation allows the Conservation Authority to prohibit or regulate the straightening, changing, diverting, or interfering with the existing channel of a river, creek, stream, or watercourse.

Based on the remedial works that are proposed along the west bank of the Moira River (reconstruction) as well as within Young's Creek (sediment removal and wetland rehabilitation), it is anticipated that a permit "To Construct, Place Fill, or Alter a Waterway" will be required from the Moira River Conservation Authority (MRCA) c/o Quinte Conservation (QC).

9.4 Ministry of Natural Resources

Of note within the Deloro Mine Site property and in the Young's Creek Offsite Area is a Provincially Significant Wetland (PSW), the Deloro Wetland Complex. The Deloro Wetland Complex, including the area along Young's Creek south of Highway 7, was evaluated during the summer of 2000 using the 3rd Edition of the wetland evaluation manual (Snider's Ecological Services, 2000). The wetland received a total score of 688 and was evaluated as a Class 2 PSW.

The management of Ontario wetlands and lands adjacent to them is implemented through the *Wetlands Policy Statement,* which falls under the jurisdiction of the *Planning Act*. The MNR and the Minister of Municipal Affairs jointly issued the *Wetlands Policy Statement*. The policy requires that all planning jurisdictions protect PSWs such that development is not permitted in PSWs that are located within the Great Lakes—St. Lawrence Region. Development and alteration may be permitted on lands adjacent to PSWs only if it does not result in:

- Loss of wetland function
- Subsequent demand for future development that will negatively impact existing wetland functions
- Conflict with existing site-specific management practices
- Loss of wetland area

An Environmental Impact Study (EIS) would have to be prepared in order to permit development on these adjacent lands.

Consultation is required with the MNR, and possibly the Minister of Municipal Affairs, to determine whether any of the project components, such as construction of the Young's Creek Area onsite containment cell and dredging, constitutes wetland "development" and whether the project can be permitted. Also, the MNR would need to determine whether an EIS would need to be completed.

The MNR is also responsible for issuing Work Permits under the authority and provisions of several different Provincial Acts. If the project is allowed to proceed, the Provincial Acts that apply to this project would have to be determined in consultation with the MNR. The following Provincial Acts and their regulations are considered in the application for a Work Permit.

Forest Fire Prevention Act*:* The MNR administers this Act. A Work Permit is required to authorize any work on Crown land, and to ensure that adequate forest fire precautions and equipment are in place.

Lakes and Rivers Improvement Act: The purpose of this Act is to manage the use of the lakes and rivers in Ontario, and to regulate improvements to them. The Act provides for the preservation of public rights in or over water; protection of the interests of riparian owners; management of fish, wildlife, and other natural resources dependent on such waters; preservation of natural amenities; and suitability of the location and nature of improvements. The *Lakes and Rivers Improvement Act* gives the MNR the mandate to manage water-related activities, particularly in the areas outside the jurisdiction of Conservation Authorities.

Public Lands Act*:* This Act, which is administered by the MNR, authorizes the construction of roads on Crown lands, sets out Crown cost-sharing of company roads, limitations on liability and tenure for private forest roads and camp areas, and defines the applicability of the *Highway Traffic Act* on access roads.

As part of the application for a Work Permit, each project proponent must complete and apply for "Parts" of the permit. The determination of which Parts (i.e. A through F) are applicable to the project is conducted in consultation with the MNR. The Parts that must be taken into consideration when applying for a Work Permit are briefly described below:

- *Part A*: Fire Prevention and Suppression/Logging Activities
- *Part B*: Mineral Exploration Activities
- *Part C*: Building Construction
- *Part D*: Application to do Work on Shore Lands
- *Part E*: Roads, Trails, or Water Crossings
- *Part F*: Works Within a Waterbody

Based on the work proposed at the Deloro Mine Site, a Work Permit will be required from the MNR. Several Parts to the application will have to be completed possibly including, but not limited to, Parts A, D, and F. It is anticipated that the MNR will include conditions pertaining to work in the PSW with those issued as part of the Work Permit.

9.5 Department of Fisheries and Oceans/ Canadan Coast Guard

9.5.1 Navigable Waters Protection Act (NWPA)

The purpose of the NWPA is to protect the public right to marine navigation, and to ensure unobstructed passage of vessels in Canadian waters. Any construction, modification, or repair of a work that will interfere with navigable waterways must be approved, or concurrence provided by the Department of Fisheries and Oceans (DFO), and is administered by the Canadian Coast Guard (CCG). The removal of obstructions to navigation, and the provision and maintenance of lights and markers required for safe navigation are also covered under this Act. Although the section of the Moira River that passes through the site has limited use for boating, many parts of the Moira River are navigable and the CCG should be consulted on the final cleanup plan for the site.

9.5.2 Fisheries Act

The federal Minister of Fisheries and Oceans has the legislative responsibility for the administration and enforcement of the federal *Fisheries Act*. The *Fisheries Act* protects and conserves fish and fish habitats, and has the power to deal with damage to fish habitat, destruction of fish, obstruction of fish passage, necessary flow requirements for fish, and the control of deleterious substances. Section 35(1) of the federal *Fisheries Act* states that "no person shall carry on any work or undertaking that results in the harmful alteration, disruption, or destruction (HADD) of fish habitat". Any proposed works and activities that are likely to alter or damage fish habitat must be reviewed and authorized by the DFO. The Conservation Authorities have agreements with the DFO in the evaluation and processing of applications, and therefore would also have to be consulted.

It is important to note that DFO has also developed a Policy for the Management of Fish Habitat which includes a No Net Loss guiding principle. This principle is applied to any proposed development that would result in a loss of productive fish habitat. The regulatory agency would review the measures to determine if they meet not only the No Net Loss of fish habitat, but also the DFO's long-term policy objective of achieving an overall net gain of the productive capacity of fish habitats. Therefore, works requiring an authorization from the DFO typically include a Fisheries Compensation Plan which describes the measures taken to realize an overall net gain in the productive capacity of fish habitats as a result of the project.

A section of the west bank of the Moira River in the Industrial Area will be reconstructed, and a significant amount of work is proposed within Young's Creek including the excavation of contaminated sediments/soils and wetland rehabilitation. As this will affect fish habitat, a Fisheries Act authorization will be required, and a Fisheries Compensation Plan may have to be prepared. In addition, application for a blasting permit may be required to address "destruction of fish by any other means" (under the *Fisheries Act*), since a portion of the onsite containment cell will be located in Young's Creek.

9.6 Environmental Assessment and CNSC Licensing

The *Nuclear Safety and Control Act* (NSCA) mandates the Canadian Nuclear Safety Commission (CNSC) to regulate all aspects of the nuclear industry in Canada, including the management and isolation of nuclear wastes. Paragraph 26 of the NSCA states that:

> "Subject to the regulations, no person shall, except in accordance with a licence,…possess…manage, store, or dispose of a nuclear substance. . ."

It is with respect to this paragraph that the MOE seeks to obtain a licence to manage and store, at various locations on the Deloro Mine Site, the radioactive wastes present on the site. Conceptual waste isolation scenarios are presented in Section 3.4 of this and other Closure Plans for radioactive (and non-radioactive) materials.

CNSC's authorization of the project would be provided through the issuance of a Waste Nuclear Substance Licence (WNSL) for the possession, management, and storage of nuclear substances, pursuant to subsection 24(2) of NSCA.

As previously noted, because nuclear waste management and storage is a physical activity listed in the "Inclusion List Regulation" of the CEAA, the proposed project is subject to the federal EA process. Therefore, the licencing and the federal EA processes are closely linked, as explained below.

The screening level EA process being followed for this project is outlined in Section 2.2. At the completion of the EA study, the proponent must summarize the process and the results of the EA into a report that is submitted to the RA for its review. Once the RA is satisfied that the EA has met the initial scope, the report is then submitted to the members of the CNSC for its approval. A hearing in which the proponent presents the project and where the public is invited to voice its concerns or support may be required.

Following the approval of the results of the EA by the CNSC, an application for a WNSL must be formally submitted by the proponent in accordance with the General Nuclear Safety and Control Regulations, and Nuclear Substance and Radiation Devices Regulations of the NSCA. A WNSL is applicable, as opposed to a Class Ib Nuclear Facility Licence, because mainly chemical wastes are being managed with the presence of some radioactive materials.

As part of the application for a WNSL, safety analyses must be conducted to ensure radiation exposures to both workers and the public are acceptable during normal and abnormal conditions at the site.

Some applicable portions of the General Nuclear Safety and Control Regulations which must be addressed in the application are as follows:

> 3 (1) (*e*) the proposed measures to ensure compliance with the *Radiation Protection Regulations* and the *Nuclear Security Regulations*;
> (*f*) any proposed action level for the purpose of section 6 of the *Radiation Protection Regulations*;
> (*g*) the proposed measures to control access to the site of the activity to be licensed and the nuclear substance, prescribed equipment or prescribed information;
> (*h*) the proposed measures to prevent loss or illegal use, possession or removal of the nuclear substance, prescribed equipment or prescribed information;

> (*i*) a description and the results of any test, analysis or calculation performed to substantiate the information included in the application;
> (*j*) the name, quantity, form, origin and volume of any radioactive waste or hazardous waste that may result from the activity to be licensed, including waste that may be stored, managed, processed or disposed of at the site of the activity to be licensed, and the proposed method for managing and disposing of that waste;

Some applicable sections of the Nuclear Substance and Radiation Devices Regulations are as follows:

> **3.** (1) An application for a licence in respect of a nuclear substance or a radiation device, other than a licence to service a radiation device, shall contain the following information in addition to the information required by section 3 of the *General Nuclear Safety and Control Regulations*:
> (*a*) the methods, procedures and equipment that will be used to carry on the activity to be licensed;
> (*b*) the methods, procedures and equipment that will be used while carrying on the activity to be licensed, or during and following an accident, to
> (i) monitor the release of any radioactive nuclear substance from the site of the activity to be licensed,
> (ii) detect the presence of and record the radiation dose rate and quantity in becquerels of radioactive nuclear substances at the site of the activity to be licensed,
> (iii) limit the spread of radioactive contamination within and from the site of the activity to be licensed, and
> (iv) decontaminate any person, site or equipment contaminated as a result of the activity to be licensed;
> (*c*) a description of the circumstances in which the decontamination referred to in subparagraph (*b*)(iv) will be carried out;

Following submission of the application, and any clarifications and/or additional materials required by CNSC staff, a draft licence is then prepared by CNSC staff, discussed with the proponent, and ultimately presented to the members of the CNSC for approval. A hearing in which the proponent presents its application, and where the public is invited to voice its concerns or support may be required. Upon acceptance, a WNSL is issued and remedial work can begin under the conditions of the Licence.

9.7 Mining Act

The regulatory considerations relevant to the Deloro project were examined early in the project, and have been refined as the project has progressed. The document entitled *Deloro Mine Rehabilitation Project – Development of Closure Criteria, Final Report* (CG&S, October 1998) summarized the application of the *Mining Act* to the Deloro project. Even though the Crown (i.e. the Provincial Government) is exempt from the requirements of the *Mining Act,* the Closure Plans have been developed to satisfy, in general, the requirements of the document entitled *Rehabilitation of Mines, Guidelines for Proponents* (MNDM, 1995). MNDM has agreed to review the Closure Plans relative to accepted standards for closure and rehabilitation of mines in Ontario, although a specific approval will not be issued.

10. References

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APPENDIX A

SUMMARY OF MAJOR COST ITEMS FOR MINE AREA CLOSURE PLAN

APPENDIX A

Summary of Major Cost Items for Mine Area Closure Plan

Opinions of Probable Construction Cost

In providing opinions of probable cost, MOE understands that CH2M HILL has no control over the cost or availability of labour, equipment or materials, or over market conditions or the potential Contractor's method of pricing. CH2M HILL makes no warranty, express or implied, that the bids or the negotiated cost of the Work will not vary from the opinion of probable construction cost.

CH2M HILL has made efforts to acquire area specific rates for materials, labour, and equipment whenever possible. The suitability of said materials to the intended purposes were not verified and will need to be determined prior to any construction activities. Where a local source or supplier could not be identified, industry budgetary tools such as the R.S. Means Company Inc. costing guide were used to assign a typical value. Appropriate regional coefficients were applied where necessary to adjust the typical costs to address regional conditions.

Each specific area of interest has been examined as an independent project. Any possible synergies associated with co-execution of various areas were ignored. Prices provided include the federal Goods and Services Tax (GST).

Volumes and areas were determined using existing available information. No additional investigations were performed to confirm or refute the estimates. Some estimates such as potential water volumes were based on engineering experience from other similar projects. Probable construction costs were based on typical weather conditions and may require adjustments due to extreme conditions.

Certain construction costs such as overhead, insurance, and various construction bonds will vary based on the potential Contractor. Financial strength, experience, and previous history all play a role in determining the rates that will be applied to a particular Contractor. These sums were determined as a percentage of the total costs based on industry averages.

Several of the site remediation options involved additional pumping to the arsenic treatment plant located in the Industrial Area. The application of a varied number of options over the four main areas will result in increases and decreases of the total treated water volume. At this conceptual stage it is difficult to determine whether there will be a net increase or decrease to the volume of water to be treated. Therefore, the operation and maintenance of the arsenic treatment plant has only been considered in the Industrial Area Closure Plan. Actual operation and maintenance costs over the last decade were used to develop a weighted-average and one standard deviation was added to this value in an effort to create a conservative estimate. Wastewater treatment considerations for all other areas were limited to collection and transmission to the equalization pond (i.e. equalization/storage basin).

Finally, a 15 percent contingency was added to the final capital cost (before taxes, overhead, insurance, and bonds) and a 5 percent contingency was added to the final OMM costs (before taxes).

The net present value costs presented in the following cost breakdown are the sum of the capital cost and the net present value of the OMM costs. The annual OMM costs have been transformed to a net present value assuming an effective interest rate of 5 percent and a planning horizon of 20 years. The effective interest rate includes inflationary effects. It should be noted that OMM effort and costs will be required beyond the 20-year horizon. The 20-year period was selected based on the assumption that it is a reasonable period for budgetary planning purposes.

Cost opinions were developed based on information available at the time this report was prepared and are expected to have an accuracy on the order of +/- 25 percent. Use of this information for project budgeting purposes should include a factor for escalation if the contract will not proceed in the same calendar year.

Appendix A
Breakdown of Captial Costs for Work Packages and Operations, Maintenance, and Monitoring Costs

	Cost	Insurance	Overhead	Performance Bond	Labour and Material Bond	Remote Area Cost	Final Costs*
MMA-WP#1(a): Excavate Highly Leachable Wastes, Low-Level Radioactive Slag, and Infill/Vegetate and Reconstruct Riverbank (if required)							
Set-up	$35,107	$569	$1,369	$527	$527	$351	$38,450
Access Routes	$27,259	$442	$1,063	$409	$409	$273	$29,854
Silt Fencing along Moira River Bank (west side)	$1,438	$23	$56	$22	$22	$14	$1,575
Watercourse Rerouting North of Gatling Shaft	$146,890	$2,380	$5,729	$2,203	$2,203	$1,469	$160,874
Washpad	$16,687	$270	$651	$250	$250	$167	$18,276
Mobilization of Equipment	$2,190	$35	$85	$33	$33	$22	$2,398
Excavation and Removal of Arsenic Dump Material, Highly Leachable Soil, and Low-Level Radioactive Slag (includes infilling and grading)	$589,793	$9,555	$23,002	$8,847	$8,847	$5,898	$645,941
Daily Surface Water Quality Sampling	$3,449	$56	$134	$52	$52	$34	$3,777
Moira River Bank Materials Excavation (if required), Consolidation, and Restoration	$115,553	$1,872	$4,507	$1,733	$1,733	$1,156	$126,554
Revegetation	$30,668	$497	$1,196	$460	$460	$307	$33,588
Consolidation of Wastes in Industrial Area (highly leachable wastes and radioactive slag)	$30,668	$497	$1,196	$460	$460	$307	$33,588
Total	**$999,702**	**$16,195**	**$38,988**	**$14,996**	**$14,996**	**$9,997**	**$1,095,000**
RMA-WP#1(b): Excavate Impacted Soils and Infill/Vegetate							
Access Routes	$107,746	$1,745	$4,202	$1,616	$1,616	$1,077	$118,003
Excavation and Removal of Impacted Soil (includes infilling, grading, and revegation)	$210,063	$3,403	$8,192	$3,151	$3,151	$2,101	$230,061
Consolidation of Impacted Soils in Industrial Area	$10,674	$173	$416	$160	$160	$107	$11,690
Total	**$328,483**	**$5,321**	**$12,811**	**$4,927**	**$4,927**	**$3,285**	**$360,000**
MMA-WP#2(a): Cover Waste Rock and Marginally Leachable Soil, and Vegetate							
Grading and Covering of Waste Rock	$243,765	$3,949	$9,507	$3,656	$3,656	$2,438	$266,972
Simple Earth (Clay) Caps over Marginally Leachable Soils	$224,652	$3,639	$8,761	$3,370	$3,370	$2,247	$246,038
Revegetation of Waste Rock and Simple Earth (Clay) Caps	$16,118	$261	$629	$242	$242	$161	$17,653
Total	**$484,535**	**$7,849**	**$18,897**	**$7,268**	**$7,268**	**$4,845**	**$531,000**
RMA-WP#2(b): Cover Waste Rock and Vegetate							
Grading and Covering of Waste Rock	$117,581	$1,905	$4,586	$1,764	$1,764	$1,176	$128,775
Revegetation	$5,050	$82	$197	$76	$76	$50	$5,531
Total	**$122,631**	**$1,987**	**$4,783**	**$1,839**	**$1,839**	**$1,226**	**$134,000**
MMA-WP#3: Upgrade Tuttle Shaft Pumping System Installation and Install Overland Piping to Industrial Area							
Install Pump and Overland Piping	$66,359	$1,075	$2,588	$995	$995	$664	$72,676
Total	**$66,359**	**$1,075**	**$2,588**	**$995**	**$995**	**$664**	**$73,000**
Total Captial Cost							**$2,193,000**
Operation, Maintenance, and Monitoring (for 20 years, present investment at 5%)							
Collection system requirements	$22,916	$0	$894	NA	NA	$229	$24,039
Collection system maintenance	$67,035	$0	$2,614	NA	NA	$670	$70,320
Cap Maintenance	$163,501 ($19,369**)***	$0	$6,377	NA	NA	$1,635	$171,513
Monitoring program includes physical stability, fence inspection, surface and groundwater quality, pumping and conveyance inspections, and biomonitoring	$786,727 ($47,061**)	$0	$30,682	NA	NA	$7,867	$825,277
Total Operation, Maintenance, and Monitoring Costs	**$1,040,180**	**$0**	**$40,567**	**$0**	**$0**	**$10,402**	**$1,091,000**
Grand Total	**$3,041,890**	**$32,428**	**$118,634**	**$30,026**	**$30,026**	**$30,419**	**$3,284,000**

All capital costs include GST and a 15% contingency (before taxes, overhead, insurance, and bonds).
All OMM costs include GST and a 5% contingency (before taxes).
*Rounded to nearest $1,000. All costs have been developed using 2004 pricing and do not include an escalation factor.
**Annual (Weighted) OMM Costs (before overhead and remote area costs).
***Total Annual (Weighted) OMM Costs (before overhead and remote area costs) includes all three costs for collection system requirements, collection system maintenance, and cap maintenance.